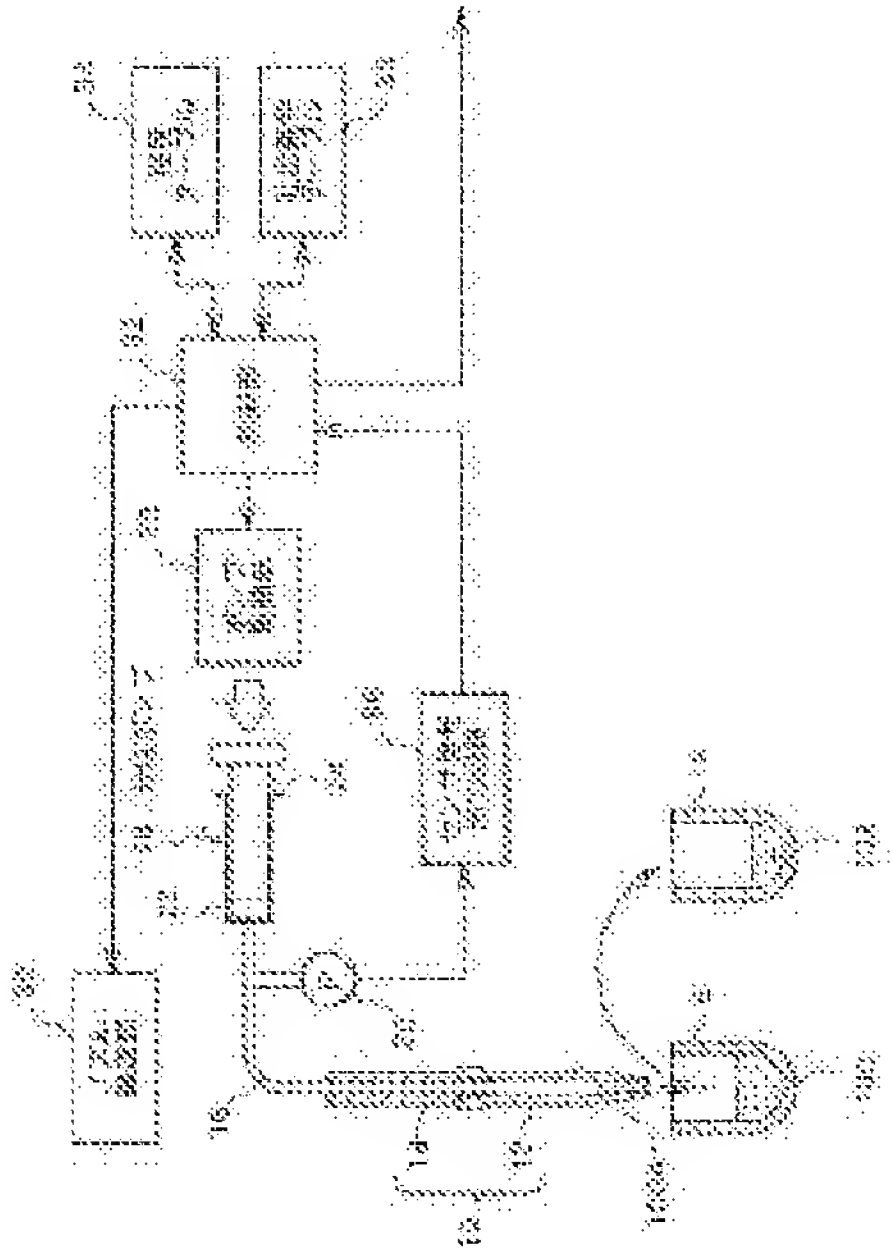


DISPENSING APPARATUS

Patenttinumero: JP2003028886 (A)
Julkaisupäivä: 2003-01-29
Keksijä(t): SHIYUU CHIYUUYOU; SAITO HIROKI
Hakija(t): ALOKA CO LTD
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Julkaisuja muista maista
JP3740392 (B2)

Tiivistelmä **JP 2003028886 (A)**
PROBLEM TO BE SOLVED: To set optimum operating conditions according to the viscosity of liquid in a dispensing apparatus. SOLUTION: Based on the waveform of pressure when sucking liquid 100, timing for separating a nozzle 10 from the liquid surface of the liquid 100 is determined, and at the same time the viscosity in the liquid 100 is estimated. The discharge conditions of liquid are determined according to the estimated viscosity. The discharge conditions include conditions such as a discharge system, a discharge speed, and a discharge stroke amount.



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CLAIMS

[Claim(s)]

[Claim 1]A nozzle and a distributive-pouring pump connected via piping to said nozzle, A pressure sensor connected to said piping, and when making said nozzle advance into an oil level of an object fluid and attracting an object fluid, A syneresis timing determining means which judges syneresis timing which is based on a pressure wave form detected by said pressure sensor, and raises said nozzle after suctioning operation completion of said distributive-pouring pump, An implication, a distributive-pouring device, wherein said nozzle can pull up from said object fluid to said syneresis timing.

[Claim 2]The device comprising according to claim 1:

A means by which said syneresis timing determining means calculates inclination of said pressure wave type after operation completion of said distributive-pouring pump.

A means to determine said syneresis timing when said inclination fulfills flattening conditions.

[Claim 3]In the time of suction of a nozzle, a distributive-pouring pump connected via piping to said nozzle, a pressure sensor connected to said piping, and an object fluid by said nozzle, A physical-properties estimation means which is based on a pressure wave form detected by said pressure sensor, and presumes the physical properties of said object fluid, A distributive-pouring device characterized by breathing out said object fluid according to said set-up discharge condition including a discharge condition set part which sets up a discharge condition at the time of regurgitation of an object fluid by said nozzle according to said presumed physical properties.

[Claim 4]A distributive-pouring device, wherein said discharge condition set part chooses a regurgitation method of either an air regurgitation method which separates said nozzle from an oil level and performs regurgitation, and a regurgitation method in liquid which contacts said nozzle on an oil level and performs regurgitation in the device according to claim 3.

[Claim 5]In the device according to claim 4, said discharge condition set part, In the case of said air regurgitation method, working speed of a distributive-pouring pump, an operation amount of a distributive-pouring pump, A distributive-pouring device determining at least one in reversing operation start timing of a distributive-pouring pump, and the amount of reversing operation of a distributive-pouring pump, and determining at least one of the standby time to a syneresis after working speed of a distributive-pouring pump, and operation of a distributive-pouring pump in the case of said regurgitation method in liquid.

[Claim 6]A nozzle and a distributive-pouring pump connected via piping to said nozzle, A pressure sensor connected to said piping, and when making said nozzle advance into an oil level of an object fluid and attracting an object fluid, A flattening stage judging means which is based on a pressure wave form detected by said pressure sensor, and judges a flattening stage of a pressure after suctioning operation completion of said distributive-pouring pump, A syneresis timing determining means which judges syneresis timing of said nozzle according to said flattening stage, A viscosity estimation means which presumes viscosity of said object fluid based on a return period from after said suctioning operation completion to said flattening stage, A distributive-pouring device characterized by setting up said syneresis timing and said discharge condition accommodative according to said object fluid including a discharge condition set part which sets up a discharge condition of said object fluid according to said presumed viscosity.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]Especially this invention relates to suction according to the physical properties of the object fluid, and control of the regurgitation about a distributive-pouring device.

[0002]

[Description of the Prior Art]A distributive-pouring device is a device which attracts the fluid in a container and carries out the regurgitation of the fluid to 1 or two or more of other containers by a nozzle. At the time of fluid suction, a nozzle is inserted into an oil level and, specifically, suction of a fluid is made by carrying out suctioning operation of the distributive-pouring pump (syringe pump) connected to the nozzle. Incidentally, according to the oil-level descent accompanying fluid suction, a nozzle location is also followed and lowering controls are usually carried out.

[0003]Immediately after suctioning operation completion of a distributive-pouring pump, the inside of a nozzle still serves as negative pressure (it is low pressure from atmospheric pressure), and a fluid is succeedingly absorbed in a nozzle until the pressure in a nozzle therefore becomes close to atmospheric pressure. And when a pressure equilibrium is planned, it stops and suction completes movement of the fluid into a nozzle. In this case, it depends for a period (waiting period) until suction (movement) of a fluid is substantially completed from the suctioning operation completion time of a distributive-pouring pump on the physical properties (especially viscosity) of a fluid depending on suction quantity till then, a suction speed, etc. In the device, the syneresis timing which pulls up a nozzle upwards after suction on the assumption that the waiting period which can also attract such a fluid certainly was conventionally set up uniformly supposing the fluid with the highest viscosity.

[0004]On the other hand, even if the discharge velocity and the amount of discharging (the

amount of reversing operation performed in order to improve a liquid piece at the telophase of the air regurgitation is included) of a distributive-pouring pump are the same at the time of the regurgitation (case of the air regurgitation method mentioned especially later), By the difference in the physical properties (especially viscosity) of a fluid, a difference arises in actual discharge quantity in many cases. If viscosity is low, the direction which raised discharge velocity can shorten distributive-pouring processing time. However, in the device, the discharge condition was conventionally set up uniformly supposing the fluid with the highest viscosity.

[0005]As a regurgitation method, the air regurgitation method and the regurgitation method in liquid are known. In the state where other fluids are already poured into the discharge destination container, the aforementioned air regurgitation method is a method which performs the regurgitation rather than the oil level in the container concerned in the upper part, when carrying out the regurgitation of other fluids. According to this method, problems, such as contamination produced when the fluid in a container adheres to a nozzle tip, can be prevented. Since only the fluid to pour distributively has adhered to the nozzle tip, in the case of a disposable nozzle tip, reuse of a chip can be performed when pouring the same fluid distributively again. In the case of a non disposable nozzle tip, the washing process of a nozzle can be skipped. However, when the viscosity of the fluid which carries out the regurgitation is very high, it is difficult to secure distributive-pouring accuracy, or, generally it needs to make discharge velocity small. On the other hand, in the state where other fluids are already poured in into the discharge destination container, the aforementioned regurgitation method in liquid is a method which makes a nozzle (tip) advance into the oil level in the container concerned, and carries out the regurgitation of the fluid, when carrying out the regurgitation of other fluids. Even if the nozzle tip is not touching an oil level in front of the regurgitation, it is contained in the regurgitation method in liquid also when the oil level after the regurgitation becomes a position higher than a nozzle tip. According to this method, even if the viscosity of the fluid which carries out the regurgitation is high, the regurgitation can be performed comparatively smoothly and there is an advantage that a liquid piece is also good. However, when other fluids are already contained in the discharge destination container, other fluids in a container adhere to a nozzle tip, and, as a result, problems, such as contamination, arise, or processing of nozzle washing etc. becomes indispensable.

[0006]Thus, although there are merits and demerits in two regurgitation methods, in the device, only one of methods is conventionally adopted for each device of every. The device indicated to JP,5-107174,A can be raised as a distributive-pouring device with a measurement-of-viscosity function. This device seems however, not to change an operating condition according to the measured viscosity.

[0007]This invention is made in view of above-mentioned conventional SUBJECT, and the

purpose is to raise distributive-pouring processing efficiency according to the physical properties of the fluid used as the candidate for distributive pouring.

[0008]Other purposes of this invention are enabling it to reduce the suction treatment time of the fluid as much as possible according to the physical properties of the fluid used as the candidate for distributive pouring.

[0009]Other purposes of this invention are setting up the operating condition at the time of the optimal regurgitation, and raising distributive-pouring accuracy by this according to the physical properties of the fluid used as the candidate for distributive pouring, and enabling it to reduce regurgitation processing time.

[0010]

[Means for Solving the Problem](1) To achieve the above objects, this invention, A nozzle and a distributive-pouring pump connected via piping to said nozzle, A pressure sensor connected to said piping, and when making said nozzle advance into an oil level of an object fluid and attracting an object fluid, A syneresis timing determining means which judges syneresis timing which is based on a pressure wave form detected by said pressure sensor, and raises said nozzle after suctioning operation completion of said distributive-pouring pump, Said nozzle can pull up from said object fluid to an implication and said syneresis timing.

[0011]According to the above-mentioned composition, when attracting an object fluid by a nozzle, syneresis timing of a nozzle is judged from a pressure wave form after suctioning operation completion of a distributive-pouring pump. Here, if it responds to the physical properties of an object fluid, and pressure wave forms after suctioning operation completion differ, respond to the pressure wave form and syneresis timing is judged, the minimum suction time can be set up according to viscosity of an object fluid.

[0012]Desirably, said syneresis timing determining means contains a means to calculate inclination of said pressure wave type after operation completion of said distributive-pouring pump, and a means to determine said syneresis timing when said inclination fulfills flattening conditions.

[0013](2) To achieve the above objects this invention, A nozzle and a distributive-pouring pump connected via piping to said nozzle, A physical-properties estimation means which is based on a pressure wave form detected by said pressure sensor at the time of suction of a pressure sensor connected to said piping and an object fluid by said nozzle, and presumes the physical properties of said object fluid, According to said set-up discharge condition, said object fluid is breathed out including a discharge condition set part which sets up a discharge condition at the time of regurgitation of an object fluid by said nozzle according to said presumed physical properties.

[0014]Since according to the above-mentioned composition pressure wave forms at the time of those suction differ when the physical properties of an object fluid differ, it is based on the

pressure wave form, the physical properties of an object fluid are presumed, and a suitable discharge condition is set up according to the physical properties. When presuming physical properties (especially viscosity) from a pressure wave form, it may be made to use characteristic quantity, such as a standup (rapid rise (return) period of a pressure) of falling in early stages of suction (between falling phases with a rapid pressure, or its rapid failure-of-pressure width), and a telophase of suction, or its rapid pressure-buildup width.

[0015]Desirably, said discharge condition set part chooses a regurgitation method of either an air regurgitation method which separates said nozzle from an oil level and performs regurgitation, and a regurgitation method in liquid which contacts said nozzle on an oil level and performs regurgitation. In the case of said air regurgitation method, desirably said discharge condition set part Working speed of a distributive-pouring pump, At least one in an operation amount of a distributive-pouring pump, reversing operation start timing of a distributive-pouring pump, and the amount of reversing operation of a distributive-pouring pump is determined, and, in the case of said regurgitation method in liquid, at least one of the standby time to a syneresis after working speed of a distributive-pouring pump and operation of a distributive-pouring pump is determined.

[0016]Usually, an air regurgitation method is chosen, and when especially viscosity is high, it may be made to choose regurgitation in liquid. In this case, exchange of a nozzle (or nozzle tip), nozzle washing, etc. are made if needed. Generally, if viscosity is low, discharge velocity will be enlarged, and discharge velocity will be made small if viscosity is high. Thereby, distributive-pouring processing speed improves. Here, conditions (inversion timing, the amount of reversing operation, etc.) of inversion suctioning operation in an air regurgitation completion time are also further included in a discharge condition.

[0017](3) To achieve the above objects this invention, A nozzle and a distributive-pouring pump connected via piping to said nozzle, A pressure sensor connected to said piping, and when making said nozzle advance into an oil level of an object fluid and attracting an object fluid, A flattening stage judging means which is based on a pressure wave form detected by said pressure sensor, and judges a flattening stage of a pressure after suctioning operation completion of said distributive-pouring pump, A syneresis timing determining means which judges syneresis timing of said nozzle according to said flattening stage, A viscosity estimation means which presumes viscosity of said object fluid based on a period from after said suctioning operation completion to said flattening stage, According to said object fluid, said syneresis timing and said discharge condition are set up accommodative including a discharge condition set part which sets up a discharge condition of said object fluid according to said presumed viscosity.

[0018]

[Embodiment of the Invention]Hereafter, the suitable embodiment of this invention is described

based on a drawing.

[0019]The entire configuration of the distributive-pouring device concerning this invention is shown in drawing 1 as a block diagram. In drawing 1, the nozzle 10 comprises the nozzle base 14 and the nozzle tip 12 in this embodiment. The nozzle base 14 is constituted by the metal of pipe shape, etc., and the upper bed side of the nozzle tip 12 fits into the lower end side. The nozzle tip 12 is constituted by transparent members, such as resin, and it can detach and attach freely to the nozzle base 14 as mentioned above. The nozzle tip 12 is used as what is called a disposable type.

[0020]The nozzle 10 constituted as mentioned above is connected to the distributive-pouring pump 18 via the piping 16. It is constituted by the air tube etc. and the piping 16 is constituted by the piston 24 at which the distributive-pouring pump 18 moves in the syringe 22 and its inside. If the pressure in the nozzle 10 will increase, the regurgitation of a fluid will be performed, if the piston 24 is advanced to the syringe 22, and the piston 24 is retreated to the syringe 22 on the other hand, the pressure in the nozzle 10 will become low, namely, it will become negative pressure, and suction of a fluid will be performed.

[0021]In this embodiment, the pressure sensor 20 is connected to the piping 16, and it is outputted to the control section 32 which the signal outputted from the pressure sensor 20 mentions later via the sensor signal output circuit 26.

[0022]The distributive-pouring pump 18 is driven by the pump drive part 28, and the pump drive part 28 is controlled by the control section 32. The nozzle transportation part 30 conveys the three dimensional direction of the nozzle 10, and this nozzle transportation part 30 is also controlled by the control section 32.

[0023]In this embodiment, the viscosity table 34 connected to the control section 32 is a table for determining the viscosity of a fluid according to period Δt mentioned later (presumption), and uses for and explains drawing 4 later about the example. The discharge condition table 36 is a table for setting up a discharge condition according to the viscosity of the determined fluid, and uses for and explains drawing 5 later about the example.

[0024]In the distributive-pouring device constituted as mentioned above, the fluid (object fluid) 100 accommodated in the container 6 by the nozzle 10 is attracted. This is shown by the numerals 100A in drawing 1. The attracted fluid 100A is breathed out in other containers 8. Under the present circumstances, depending on the case, other fluids 102 are beforehand breathed out in other containers 8. As a regurgitation method of the fluid 100A, the air regurgitation method mentioned above or the regurgitation method in liquid can be chosen in this embodiment.

[0025]Operation and the pressure wave form of a distributive-pouring pump match, and are shown in drawing 2. In drawing 2, (A) shows operation of the distributive-pouring pump 18 shown in drawing 1, and the portion into which the waveform rose in the figure shows the

period when the distributive-pouring pump 18 is performing suctioning operation. The pressure wave form shown in (B) shows the pressure variation at the time of suction observed by the pressure sensor 20 shown in drawing 1. In here, A shows the timing of a suctioning operation start of the distributive-pouring pump 18, B shows the finishing timing of the suctioning operation of the distributive-pouring pump 18, and C shows the return timing in which the pressure wave form carried out flattening.

[0026]Namely, in the case where a fluid with a certain viscosity is attracted as shown in drawing 2 (B), A pressure will fall in the negative pressure direction from immediately after the suctioning operation start rapidly, a pressure will decrease with fixed inclination after that, a pressure will rise rapidly in the atmospheric pressure direction with the end of suctioning operation, and it will converge gently-sloping to fixed negative pressure after that. In this case, Δt shows the return period until a pressure carries out flattening and returns after the end of suctioning operation.

[0027]The timing which pulls up a nozzle from the fluid which the above-mentioned return period Δt was specified and became a candidate for suction in this embodiment based on the return period Δt , for example, That is, the physical properties of the fluid which syneresis timing was determined and became a candidate for suction based on the return period Δt , especially viscosity are presumed. And the discharge condition of the optimal fluid concerned is set up according to the viscosity.

[0028]That is, return period Δt is greatly dependent on the viscosity of the fluid used as the candidate for suction, when viscosity is high, return period Δt becomes long, and when viscosity is low, return period Δt becomes short. Then, the viscosity of a fluid is presumed by the return period Δt . Of course, the return period Δt can presume the viscosity of a fluid with sufficient accuracy by referring to the value of Δt , after taking those known parameters into consideration in order to be dependent on a suction speed, suction quantity, etc.

[0029]In this embodiment, although viscosity is presumed with it with reference to return period Δt as mentioned above, As other characteristic quantity which carries out the index of the physical properties of a fluid, as shown in drawing 2, the pressure reduction width b at the time of falling at the time of the early stages of suction, pressure-buildup width b' at the standup time of the pressure after the end of suction, etc. can also be used, and they are also available as a function of viscosity. It may be made to presume viscosity with more sufficient accuracy combining two or more characteristic quantity.

[0030]To the suction quantity mentioned above and a suction speed being known, although the viscosity of a fluid is strange, Syneresis timing etc. were determined on the assumption that the highest viscosity assumed in the former, but according to this embodiment, strange viscosity is presumed and there is an advantage that it can determine the optimal syneresis

timing. It is possible to set up the operating condition of the optimal regurgitation value according to the presumed viscosity so that it may explain in full detail behind.

[0031]An example of the technique for determining the above-mentioned return period Δt is shown in drawing 3. In drawing 3, the pressure wave form from suctioning operation finishing timing to return timing is shown selectively. The difference of the pressure value measured for every predetermined sampling period within this period calculates, and it is judged as that in which the pressure carried out flattening with the time of that difference becoming smaller than the predetermined decision value K . Absolute value ΔP of two pressure P_i in two adjoining timing, a certain timing T_i and T_{i+1} , and P_{i+1} specifically calculates, Return timing is determined with the time of the ΔP becoming smaller than the decision value K , and return period Δt is determined simultaneously with this. Of course, the technique shown in drawing 3 is an example, and can also use other techniques besides this. Anyway, when the conditions regarded as supervising the inclination of a pressure wave form and the inclination being flat are fulfilled, it is desirable to judge return timing.

[0032]The example of the viscosity table 34 shown in drawing 1 is shown in drawing 4. This viscosity table 34 is a table for determining viscosity from the above-mentioned return period Δt in the case of a certain suction quantity and a certain suction speed, and suction quantity, a suction speed, and viscosity according to the combination of return period Δt are table-ized. Of course, it may be made to ask for viscosity by a functional form. If suction quantity, a suction speed, etc. are always constant, viscosity can also be determined as a meaning from return period Δt .

[0033]Incidentally, as for such a table, it is desirable for an experiment etc. to determine beforehand.

[0034]The example of the discharge condition table 36 shown in drawing 1 is shown in drawing 5. This discharge condition table corresponds to the above air regurgitation, and is a table where the regurgitation stroke (discharge quantity) was matched for every combination of discharge velocity, viscosity, and the amount of target distributive pouring (discharge quantity). As for such a table, it is desirable to create by experiment etc. beforehand like the above-mentioned viscosity table 34. It may be made for the functional form which made the parameter discharge velocity, viscosity, and the amount of target distributive pouring without also being able to constitute a discharge condition table incidentally on the assumption that if discharge velocity is constant, and being based on a table format to determine a regurgitation stroke.

[0035]Incidentally, in this embodiment, when the control section 32 determines a discharge condition and viscosity is beyond a predetermined value, the regurgitation in liquid is chosen, and when other, the air regurgitation is chosen. When the air regurgitation is chosen, it opts for the regurgitation stroke (and discharge velocity) according to the discharge condition table 36.

When the regurgitation in liquid is chosen, the regurgitation stroke according to the amount of target distributive pouring is set as a meaning, and discharge conditions, such as standby time from discharge velocity and pump operation finish to the syneresis of a nozzle tip, are determined according to the presumed viscosity. In this embodiment, when performing the air regurgitation, the reversing operation of the distributive-pouring pump 18 is made at the time of regurgitation completion, and it is controlled so that a liquid piece becomes better by this. Also in this case, it is desirable that it is made to determine according to the presumed above-mentioned viscosity about the timing of that reversing operation start, its operation amount, etc.

[0036]Incidentally, since such reversing operation is that to which only a minute stroke is performed, it is good also as fixed conditions for not being based on viscosity about it.

[0037]Next, it explains, referring to drawing 1 for the example of the distributive-pouring device shown in drawing 1 using drawing 6 of operation.

[0038]First, in S101, the nozzle 10 is positioned on the container 6 which accommodated the fluid 100 used as the candidate for suction, and the nozzle 10 is pulled down caudad. In S102, predetermined oil-level detection is performed, and when the tip of the nozzle 10 advances about 2 mm under the oil level of the fluid 100, for example, descent of the nozzle 10 is stopped.

[0039]In S103, the suctioning operation of the distributive-pouring pump 18 is started. The fluid 100 will specifically be absorbed via the tip opening by this in the nozzle tip 12 in the nozzle 10.

[0040]In this case, although an oil level descends in connection with that suction, in this embodiment, the lowering controls of the position of the nozzle 10 accompanying descent of that oil level are made in S104.

[0041]In S105, when it is judged that suction of the fluid 100 completed only predetermined suction quantity, the suctioning operation of the distributive-pouring pump 18 is completed.

[0042]Then, in S106, as drawing 2 (B) showed, change of the pressure wave type after the end of suctioning operation is supervised, and it is judged sequentially whether a pressure gradient fulfills flattening conditions. As specifically shown in drawing 3, when difference value ΔP of the pressure for every fixed time is compared with the decision value K and the difference value ΔP becomes smaller than the decision value K, it is judged with return timing, and the nozzle 10 can pull up up by S107 by making the return timing into syneresis timing. Thus, since it is possible to pull up the nozzle 10 promptly with the time of a pressure returning to a predetermined value, the minimum nozzle waiting period can be set up according to the viscosity of a fluid, and it is possible to aim at reduction of suction time.

[0043]In the above S107, by referring to the viscosity table 34 mentioned above from return period ΔT with the nozzle rise, the viscosity of a fluid is presumed and a discharge

condition is further set up by the discharge condition table 36 etc. according to the presumed viscosity. This is performed by the control section 32. In this case, in the case of selection of regurgitation methods, such as an air regurgitation method mentioned above to the discharge condition, and a regurgitation method in liquid, and the air regurgitation, In the case of [, such as discharge velocity, stroke quantity at the time of the regurgitation, and inversion suctioning operation conditions,] the regurgitation in liquid, the conditions of everything that is called the standby time to discharge velocity and a nozzle-tip syneresis, etc. are included.

[0044]Anyway, since the viscosity of a fluid serves as known, the optimal discharge condition according to the viscosity will be chosen.

[0045]In S108, the nozzle 10 is conveyed, it is positioned on the container 8 of the regurgitation point, and the nozzle 10 is pulled down caudad after that. In S109, according to the regurgitation method selected by S107, the nozzle 10 is positioned on an oil level (i.e., the air), or the tip of the nozzle 10 is positioned in liquid.

[0046]Discharging of the distributive-pouring pump 18 is started and the flattery rise of the nozzle 10 is carried out upwards with the rise of an oil level by S111 after that S110 if needed. Of course, when performing the air regurgitation further rather than a gone up part of an oil level in the upper part, the process of S111 is unnecessary.

[0047]In S112, discharging of the distributive-pouring pump 18 is ended with the time of it being judged that the fluid of the amount of target distributive pouring, i.e., target discharge quantity, was breathed out.

[0048]In S113, it is judged according to the regurgitation in liquid, or the air regurgitation whether inversion suctioning operation is made to perform. In the case of the air regurgitation, in S114, operation of the distributive-pouring pump 18 is converted into suctioning operation for the liquid piece at the tip of a nozzle tip, and the inversion suctioning operation concerned is completed in S115 after that.

[0049]In S116, when it is judged whether the re-regurgitation about the same fluid is performed and it continues such distributive-pouring operation by the nozzle 10, repeat execution of each process from the above S108 is carried out, and discharging is performed also in such a case according to the discharge condition set up by S107.

[0050]In S117, processing of exchange of the nozzle tip 12, etc. is made if needed, and this routine is completed after that. And repeat execution of each process from S101 is carried out again if needed. In the above-mentioned embodiment, although the disposable type nozzle tip 12 was used, when, using a non disposable type nozzle, of course, the same technique as the above can be applied.

[0051]

[Effect of the Invention]As explained above, according to this invention, it is possible to raise distributive-pouring processing efficiency according to the physical properties of the fluid used

as the candidate for distributive pouring.

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TECHNICAL FIELD

[Field of the Invention]Especially this invention relates to suction according to the physical properties of the object fluid, and control of the regurgitation about a distributive-pouring device.

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EFFECT OF THE INVENTION

[Effect of the Invention]As explained above, according to this invention, it is possible to raise distributive-pouring processing efficiency according to the physical properties of the fluid used as the candidate for distributive pouring.

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TECHNICAL PROBLEM

[Description of the Prior Art]A distributive-pouring device is a device which attracts the fluid in a container and carries out the regurgitation of the fluid to 1 or two or more of other containers by a nozzle. At the time of fluid suction, a nozzle is inserted into an oil level and, specifically, suction of a fluid is made by carrying out suctioning operation of the distributive-pouring pump (syringe pump) connected to the nozzle. Incidentally, according to the oil-level descent accompanying fluid suction, a nozzle location is also followed and lowering controls are usually carried out.

[0003]Immediately after suctioning operation completion of a distributive-pouring pump, the inside of a nozzle still serves as negative pressure (it is low pressure from atmospheric pressure), and a fluid is succeedingly absorbed in a nozzle until the pressure in a nozzle therefore becomes close to atmospheric pressure. And when a pressure equilibrium is planned, it stops and suction completes movement of the fluid into a nozzle. In this case, it depends for a period (waiting period) until suction (movement) of a fluid is substantially completed from the suctioning operation completion time of a distributive-pouring pump on the physical properties (especially viscosity) of a fluid depending on suction quantity till then, a suction speed, etc. In the device, the syneresis timing which pulls up a nozzle upwards after suction on the assumption that the waiting period which can also attract such a fluid certainly was conventionally set up uniformly supposing the fluid with the highest viscosity.

[0004]On the other hand, even if the discharge velocity and the amount of discharging (the amount of reversing operation performed in order to improve a liquid piece at the telophase of the air regurgitation is included) of a distributive-pouring pump are the same at the time of the regurgitation (case of the air regurgitation method mentioned especially later), By the difference in the physical properties (especially viscosity) of a fluid, a difference arises in actual discharge quantity in many cases. If viscosity is low, the direction which raised discharge velocity can shorten distributive-pouring processing time. However, in the device, the

discharge condition was conventionally set up uniformly supposing the fluid with the highest viscosity.

[0005]As a regurgitation method, the air regurgitation method and the regurgitation method in liquid are known. In the state where other fluids are already poured into the discharge destination container, the aforementioned air regurgitation method is a method which performs the regurgitation rather than the oil level in the container concerned in the upper part, when carrying out the regurgitation of other fluids. According to this method, problems, such as contamination produced when the fluid in a container adheres to a nozzle tip, can be prevented. Since only the fluid to pour distributively has adhered to the nozzle tip, in the case of a disposable nozzle tip, reuse of a chip can be performed when pouring the same fluid distributively again. In the case of a non disposable nozzle tip, the washing process of a nozzle can be skipped. However, when the viscosity of the fluid which carries out the regurgitation is very high, it is difficult to secure distributive-pouring accuracy, or, generally it needs to make discharge velocity small. On the other hand, in the state where other fluids are already poured in into the discharge destination container, the aforementioned regurgitation method in liquid is a method which makes a nozzle (tip) advance into the oil level in the container concerned, and carries out the regurgitation of the fluid, when carrying out the regurgitation of other fluids. Even if the nozzle tip is not touching an oil level in front of the regurgitation, it is contained in the regurgitation method in liquid also when the oil level after the regurgitation becomes a position higher than a nozzle tip. According to this method, even if the viscosity of the fluid which carries out the regurgitation is high, the regurgitation can be performed comparatively smoothly and there is an advantage that a liquid piece is also good. However, when other fluids are already contained in the discharge destination container, other fluids in a container adhere to a nozzle tip, and, as a result, problems, such as contamination, arise, or processing of nozzle washing etc. becomes indispensable.

[0006]Thus, although there are merits and demerits in two regurgitation methods, in the device, only one of methods is conventionally adopted for each device of every. The device indicated to JP,5-107174,A can be raised as a distributive-pouring device with a measurement-of-viscosity function. This device seems however, not to change an operating condition according to the measured viscosity.

[0007]This invention is made in view of above-mentioned conventional SUBJECT, and the purpose is to raise distributive-pouring processing efficiency according to the physical properties of the fluid used as the candidate for distributive pouring.

[0008]Other purposes of this invention are enabling it to reduce the suction treatment time of the fluid as much as possible according to the physical properties of the fluid used as the candidate for distributive pouring.

[0009]Other purposes of this invention are setting up the operating condition at the time of the

optimal regurgitation, and raising distributive-pouring accuracy by this according to the physical properties of the fluid used as the candidate for distributive pouring, and enabling it to reduce regurgitation processing time.

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MEANS

[Means for Solving the Problem](1) To achieve the above objects, this invention, A nozzle and a distributive-pouring pump connected via piping to said nozzle, A pressure sensor connected to said piping, and when making said nozzle advance into an oil level of an object fluid and attracting an object fluid, A syneresis timing determining means which judges syneresis timing which is based on a pressure wave form detected by said pressure sensor, and raises said nozzle after suctioning operation completion of said distributive-pouring pump, Said nozzle can pull up from said object fluid to an implication and said syneresis timing.

[0011]According to the above-mentioned composition, when attracting an object fluid by a nozzle, syneresis timing of a nozzle is judged from a pressure wave form after suctioning operation completion of a distributive-pouring pump. Here, if it responds to the physical properties of an object fluid, and pressure wave forms after suctioning operation completion differ, respond to the pressure wave form and syneresis timing is judged, the minimum suction time can be set up according to viscosity of an object fluid.

[0012]Desirably, said syneresis timing determining means contains a means to calculate inclination of said pressure wave type after operation completion of said distributive-pouring pump, and a means to determine said syneresis timing when said inclination fulfills flattening conditions.

[0013](2) To achieve the above objects this invention, A nozzle and a distributive-pouring pump connected via piping to said nozzle, A physical-properties estimation means which is based on a pressure wave form detected by said pressure sensor at the time of suction of a pressure sensor connected to said piping and an object fluid by said nozzle, and presumes the physical properties of said object fluid, According to said set-up discharge condition, said object fluid is breathed out including a discharge condition set part which sets up a discharge condition at the time of regurgitation of an object fluid by said nozzle according to said presumed physical properties.

[0014]Since according to the above-mentioned composition pressure wave forms at the time of those suction differ when the physical properties of an object fluid differ, it is based on the pressure wave form, the physical properties of an object fluid are presumed, and a suitable discharge condition is set up according to the physical properties. When presuming physical properties (especially viscosity) from a pressure wave form, it may be made to use characteristic quantity, such as a standup (rapid rise (return) period of a pressure) of falling in early stages of suction (between falling phases with a rapid pressure, or its rapid failure-of-pressure width), and a telophase of suction, or its rapid pressure-buildup width.

[0015]Desirably, said discharge condition set part chooses a regurgitation method of either an air regurgitation method which separates said nozzle from an oil level and performs regurgitation, and a regurgitation method in liquid which contacts said nozzle on an oil level and performs regurgitation. In the case of said air regurgitation method, desirably said discharge condition set part Working speed of a distributive-pouring pump, At least one in an operation amount of a distributive-pouring pump, reversing operation start timing of a distributive-pouring pump, and the amount of reversing operation of a distributive-pouring pump is determined, and, in the case of said regurgitation method in liquid, at least one of the standby time to a syneresis after working speed of a distributive-pouring pump and operation of a distributive-pouring pump is determined.

[0016]Usually, an air regurgitation method is chosen, and when especially viscosity is high, it may be made to choose regurgitation in liquid. In this case, exchange of a nozzle (or nozzle tip), nozzle washing, etc. are made if needed. Generally, if viscosity is low, discharge velocity will be enlarged, and discharge velocity will be made small if viscosity is high. Thereby, distributive-pouring processing speed improves. Here, conditions (inversion timing, the amount of reversing operation, etc.) of inversion suctioning operation in an air regurgitation completion time are also further included in a discharge condition.

[0017](3) To achieve the above objects this invention, A nozzle and a distributive-pouring pump connected via piping to said nozzle, A pressure sensor connected to said piping, and when making said nozzle advance into an oil level of an object fluid and attracting an object fluid, A flattening stage judging means which is based on a pressure wave form detected by said pressure sensor, and judges a flattening stage of a pressure after suctioning operation completion of said distributive-pouring pump, A syneresis timing determining means which judges syneresis timing of said nozzle according to said flattening stage, A viscosity estimation means which presumes viscosity of said object fluid based on a period from after said suctioning operation completion to said flattening stage, According to said object fluid, said syneresis timing and said discharge condition are set up accommodative including a discharge condition set part which sets up a discharge condition of said object fluid according to said presumed viscosity.

[0018]

[Embodiment of the Invention] Hereafter, the suitable embodiment of this invention is described based on a drawing.

[0019] The entire configuration of the distributive-pouring device concerning this invention is shown in drawing 1 as a block diagram. In drawing 1, the nozzle 10 comprises the nozzle base 14 and the nozzle tip 12 in this embodiment. The nozzle base 14 is constituted by the metal of pipe shape, etc., and the upper bed side of the nozzle tip 12 fits into the lower end side. The nozzle tip 12 is constituted by transparent members, such as resin, and it can detach and attach freely to the nozzle base 14 as mentioned above. The nozzle tip 12 is used as what is called a disposable type.

[0020] The nozzle 10 constituted as mentioned above is connected to the distributive-pouring pump 18 via the piping 16. It is constituted by the air tube etc. and the piping 16 is constituted by the piston 24 at which the distributive-pouring pump 18 moves in the syringe 22 and its inside. If the pressure in the nozzle 10 will increase, the regurgitation of a fluid will be performed, if the piston 24 is advanced to the syringe 22, and the piston 24 is retreated to the syringe 22 on the other hand, the pressure in the nozzle 10 will become low, namely, it will become negative pressure, and suction of a fluid will be performed.

[0021] In this embodiment, the pressure sensor 20 is connected to the piping 16, and it is outputted to the control section 32 which the signal outputted from the pressure sensor 20 mentions later via the sensor signal output circuit 26.

[0022] The distributive-pouring pump 18 is driven by the pump drive part 28, and the pump drive part 28 is controlled by the control section 32. The nozzle transportation part 30 conveys the three dimensional direction of the nozzle 10, and this nozzle transportation part 30 is also controlled by the control section 32.

[0023] In this embodiment, the viscosity table 34 connected to the control section 32 is a table for determining the viscosity of a fluid according to period Δt mentioned later (presumption), and uses for and explains drawing 4 later about the example. The discharge condition table 36 is a table for setting up a discharge condition according to the viscosity of the determined fluid, and uses for and explains drawing 5 later about the example.

[0024] In the distributive-pouring device constituted as mentioned above, the fluid (object fluid) 100 accommodated in the container 6 by the nozzle 10 is attracted. This is shown by the numerals 100A in drawing 1. The attracted fluid 100A is breathed out in other containers 8. Under the present circumstances, depending on the case, other fluids 102 are beforehand breathed out in other containers 8. As a regurgitation method of the fluid 100A, the air regurgitation method mentioned above or the regurgitation method in liquid can be chosen in this embodiment.

[0025] Operation and the pressure wave form of a distributive-pouring pump match, and are

shown in drawing 2. In drawing 2, (A) shows operation of the distributive-pouring pump 18 shown in drawing 1, and the portion into which the waveform rose in the figure shows the period when the distributive-pouring pump 18 is performing suctioning operation. The pressure wave form shown in (B) shows the pressure variation at the time of suction observed by the pressure sensor 20 shown in drawing 1. In here, A shows the timing of a suctioning operation start of the distributive-pouring pump 18, B shows the finishing timing of the suctioning operation of the distributive-pouring pump 18, and C shows the return timing in which the pressure wave form carried out flattening.

[0026]Namely, in the case where a fluid with a certain viscosity is attracted as shown in drawing 2 (B), A pressure will fall in the negative pressure direction from immediately after the suctioning operation start rapidly, a pressure will decrease with fixed inclination after that, a pressure will rise rapidly in the atmospheric pressure direction with the end of suctioning operation, and it will converge gently-sloping to fixed negative pressure after that. In this case, Δt shows the return period until a pressure carries out flattening and returns after the end of suctioning operation.

[0027]The timing which pulls up a nozzle from the fluid which the above-mentioned return period Δt was specified and became a candidate for suction in this embodiment based on the return period Δt , for example, That is, the physical properties of the fluid which syneresis timing was determined and became a candidate for suction based on the return period Δt , especially viscosity are presumed. And the discharge condition of the optimal fluid concerned is set up according to the viscosity.

[0028]That is, return period Δt is greatly dependent on the viscosity of the fluid used as the candidate for suction, when viscosity is high, return period Δt becomes long, and when viscosity is low, return period Δt becomes short. Then, the viscosity of a fluid is presumed by the return period Δt . Of course, the return period Δt can presume the viscosity of a fluid with sufficient accuracy by referring to the value of Δt , after taking those known parameters into consideration in order to be dependent on a suction speed, suction quantity, etc.

[0029]In this embodiment, although viscosity is presumed with it with reference to return period Δt as mentioned above, As other characteristic quantity which carries out the index of the physical properties of a fluid, as shown in drawing 2, the pressure reduction width b at the time of falling at the time of the early stages of suction, pressure-buildup width b' at the standup time of the pressure after the end of suction, etc. can also be used, and they are also available as a function of viscosity. It may be made to presume viscosity with more sufficient accuracy combining two or more characteristic quantity.

[0030]To the suction quantity mentioned above and a suction speed being known, although the viscosity of a fluid is strange, Syneresis timing etc. were determined on the assumption that

the highest viscosity assumed in the former, but according to this embodiment, strange viscosity is presumed and there is an advantage that it can determine the optimal syneresis timing. It is possible to set up the operating condition of the optimal regurgitation value according to the presumed viscosity so that it may explain in full detail behind.

[0031]An example of the technique for determining the above-mentioned return period Δt is shown in drawing 3. In drawing 3, the pressure wave form from suctioning operation finishing timing to return timing is shown selectively. The difference of the pressure value measured for every predetermined sampling period within this period calculates, and it is judged as that in which the pressure carried out flattening with the time of that difference becoming smaller than the predetermined decision value K . Absolute value ΔP of two pressure P_i in two adjoining timing, a certain timing T_i and T_{i+1} , and P_{i+1} specifically calculates, Return timing is determined with the time of the ΔP becoming smaller than the decision value K , and return period Δt is determined simultaneously with this. Of course, the technique shown in drawing 3 is an example, and can also use other techniques besides this. Anyway, when the conditions regarded as supervising the inclination of a pressure wave form and the inclination being flat are fulfilled, it is desirable to judge return timing.

[0032]The example of the viscosity table 34 shown in drawing 1 is shown in drawing 4. This viscosity table 34 is a table for determining viscosity from the above-mentioned return period Δt in the case of a certain suction quantity and a certain suction speed, and suction quantity, a suction speed, and viscosity according to the combination of return period Δt are table-ized. Of course, it may be made to ask for viscosity by a functional form. If suction quantity, a suction speed, etc. are always constant, viscosity can also be determined as a meaning from return period Δt .

[0033]Incidentally, as for such a table, it is desirable for an experiment etc. to determine beforehand.

[0034]The example of the discharge condition table 36 shown in drawing 1 is shown in drawing 5. This discharge condition table corresponds to the above air regurgitation, and is a table where the regurgitation stroke (discharge quantity) was matched for every combination of discharge velocity, viscosity, and the amount of target distributive pouring (discharge quantity). As for such a table, it is desirable to create by experiment etc. beforehand like the above-mentioned viscosity table 34. It may be made for the functional form which made the parameter discharge velocity, viscosity, and the amount of target distributive pouring without also being able to constitute a discharge condition table incidentally on the assumption that if discharge velocity is constant, and being based on a table format to determine a regurgitation stroke.

[0035]Incidentally, in this embodiment, when the control section 32 determines a discharge condition and viscosity is beyond a predetermined value, the regurgitation in liquid is chosen,

and when other, the air regurgitation is chosen. When the air regurgitation is chosen, it opts for the regurgitation stroke (and discharge velocity) according to the discharge condition table 36. When the regurgitation in liquid is chosen, the regurgitation stroke according to the amount of target distributive pouring is set as a meaning, and discharge conditions, such as standby time from discharge velocity and pump operation finish to the syneresis of a nozzle tip, are determined according to the presumed viscosity. In this embodiment, when performing the air regurgitation, the reversing operation of the distributive-pouring pump 18 is made at the time of regurgitation completion, and it is controlled so that a liquid piece becomes better by this. Also in this case, it is desirable that it is made to determine according to the presumed above-mentioned viscosity about the timing of that reversing operation start, its operation amount, etc.

[0036]Incidentally, since such reversing operation is that to which only a minute stroke is performed, it is good also as fixed conditions for not being based on viscosity about it.

[0037]Next, it explains, referring to drawing 1 for the example of the distributive-pouring device shown in drawing 1 using drawing 6 of operation.

[0038]First, in S101, the nozzle 10 is positioned on the container 6 which accommodated the fluid 100 used as the candidate for suction, and the nozzle 10 is pulled down caudad. In S102, predetermined oil-level detection is performed, and when the tip of the nozzle 10 advances about 2 mm under the oil level of the fluid 100, for example, descent of the nozzle 10 is stopped.

[0039]In S103, the suctioning operation of the distributive-pouring pump 18 is started. The fluid 100 will specifically be absorbed via the tip opening by this in the nozzle tip 12 in the nozzle 10.

[0040]In this case, although an oil level descends in connection with that suction, in this embodiment, the lowering controls of the position of the nozzle 10 accompanying descent of that oil level are made in S104.

[0041]In S105, when it is judged that suction of the fluid 100 completed only predetermined suction quantity, the suctioning operation of the distributive-pouring pump 18 is completed.

[0042]Then, in S106, as drawing 2 (B) showed, change of the pressure wave type after the end of suctioning operation is supervised, and it is judged sequentially whether a pressure gradient fulfills flattening conditions. As specifically shown in drawing 3, when difference value ΔP of the pressure for every fixed time is compared with the decision value K and the difference value ΔP becomes smaller than the decision value K, it is judged with return timing, and the nozzle 10 can pull up up by S107 by making the return timing into syneresis timing. Thus, since it is possible to pull up the nozzle 10 promptly with the time of a pressure returning to a predetermined value, the minimum nozzle waiting period can be set up according to the viscosity of a fluid, and it is possible to aim at reduction of suction time.

[0043]In the above S107, by referring to the viscosity table 34 mentioned above from return period ΔT with the nozzle rise, the viscosity of a fluid is presumed and a discharge condition is further set up by the discharge condition table 36 etc. according to the presumed viscosity. This is performed by the control section 32. In this case, in the case of selection of regurgitation methods, such as an air regurgitation method mentioned above to the discharge condition, and a regurgitation method in liquid, and the air regurgitation, In the case of [, such as discharge velocity, stroke quantity at the time of the regurgitation, and inversion suctioning operation conditions,] the regurgitation in liquid, the conditions of everything that is called the standby time to discharge velocity and a nozzle-tip syneresis, etc. are included.

[0044]Anyway, since the viscosity of a fluid serves as known, the optimal discharge condition according to the viscosity will be chosen.

[0045]In S108, the nozzle 10 is conveyed, it is positioned on the container 8 of the regurgitation point, and the nozzle 10 is pulled down caudad after that. In S109, according to the regurgitation method selected by S107, the nozzle 10 is positioned on an oil level (i.e., the air), or the tip of the nozzle 10 is positioned in liquid.

[0046]Discharging of the distributive-pouring pump 18 is started and the flattery rise of the nozzle 10 is carried out upwards with the rise of an oil level by S111 after that S110 if needed. Of course, when performing the air regurgitation further rather than a gone up part of an oil level in the upper part, the process of S111 is unnecessary.

[0047]In S112, discharging of the distributive-pouring pump 18 is ended with the time of it being judged that the fluid of the amount of target distributive pouring, i.e., target discharge quantity, was breathed out.

[0048]In S113, it is judged according to the regurgitation in liquid, or the air regurgitation whether inversion suctioning operation is made to perform. In the case of the air regurgitation, in S114, operation of the distributive-pouring pump 18 is converted into suctioning operation for the liquid piece at the tip of a nozzle tip, and the inversion suctioning operation concerned is completed in S115 after that.

[0049]In S116, when it is judged whether the re-regurgitation about the same fluid is performed and it continues such distributive-pouring operation by the nozzle 10, repeat execution of each process from the above S108 is carried out, and discharging is performed also in such a case according to the discharge condition set up by S107.

[0050]In S117, processing of exchange of the nozzle tip 12, etc. is made if needed, and this routine is completed after that. And repeat execution of each process from S101 is carried out again if needed. In the above-mentioned embodiment, although the disposable type nozzle tip 12 was used, when, using a non disposable type nozzle, of course, the same technique as the above can be applied.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a block diagram showing the suitable embodiment of the distributive-pouring device concerning this invention.

[Drawing 2]It is a figure showing the relation of operation and the pressure wave form of a distributive-pouring pump.

[Drawing 3]It is an explanatory view showing the judgment method of pressure-return timing.

[Drawing 4]It is a figure showing the example of a viscosity table.

[Drawing 5]It is a figure for explaining the example of a discharge condition table.

[Drawing 6]It is a flow chart which shows the example of a distributive-pouring device of operation.

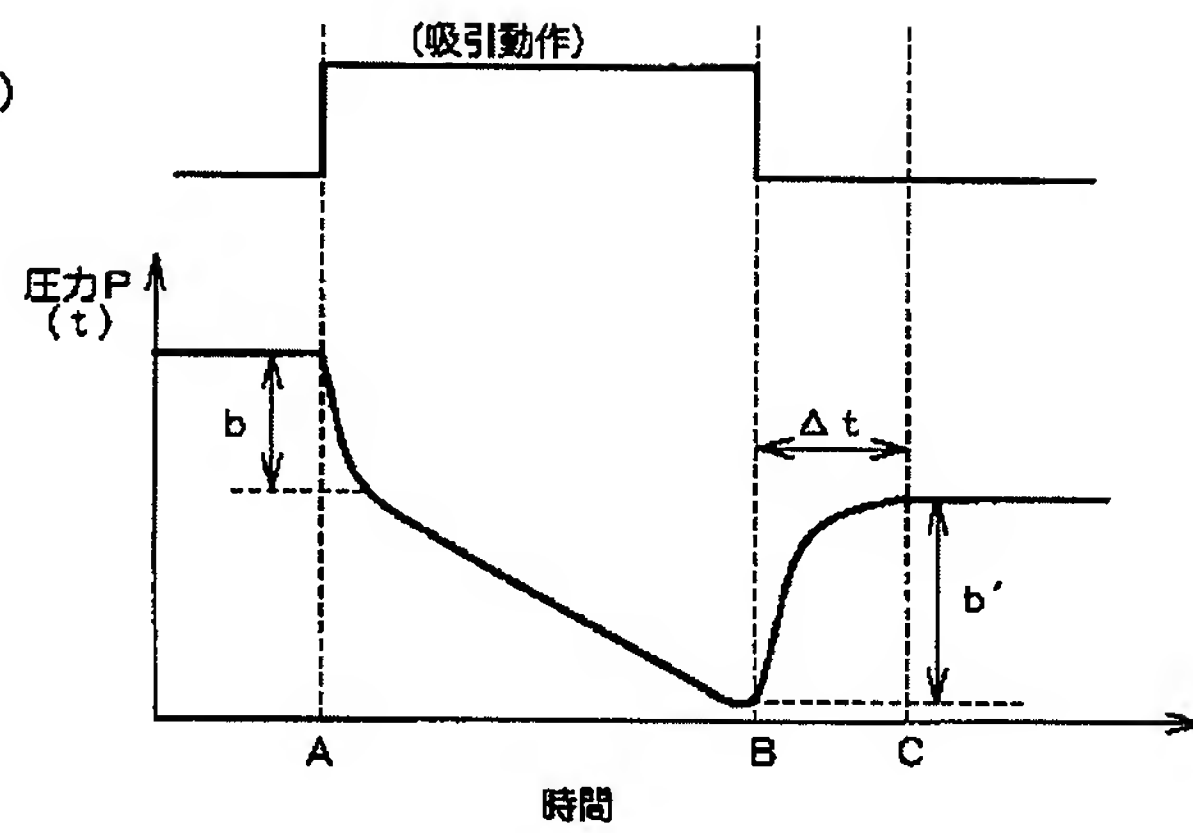
[Description of Notations]

10 A nozzle and 12 [A piston, 26 sensor-signal output circuit, 28 pump drive parts, and 30 / A nozzle transportation part and 32 / A control section and 34 / A viscosity table and 36 / Discharge condition table.] A nozzle tip and 16 Piping and 18 A distributive-pouring pump, 20 pressure sensors, 22 syringes, and 24

[Translation done.]

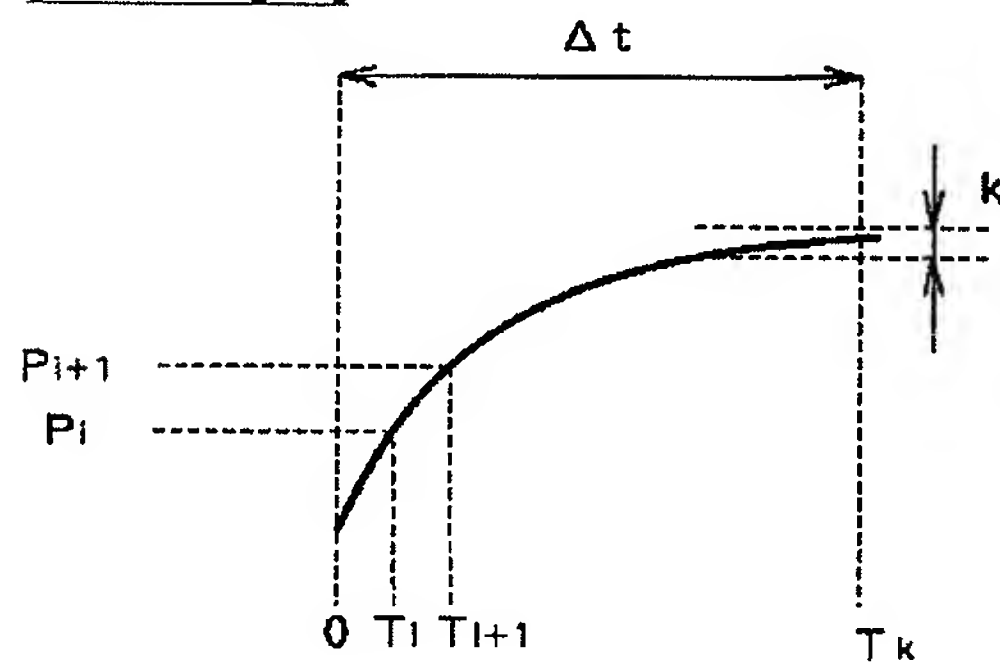
分注ポンプの動き (A)

圧力波形 (B)



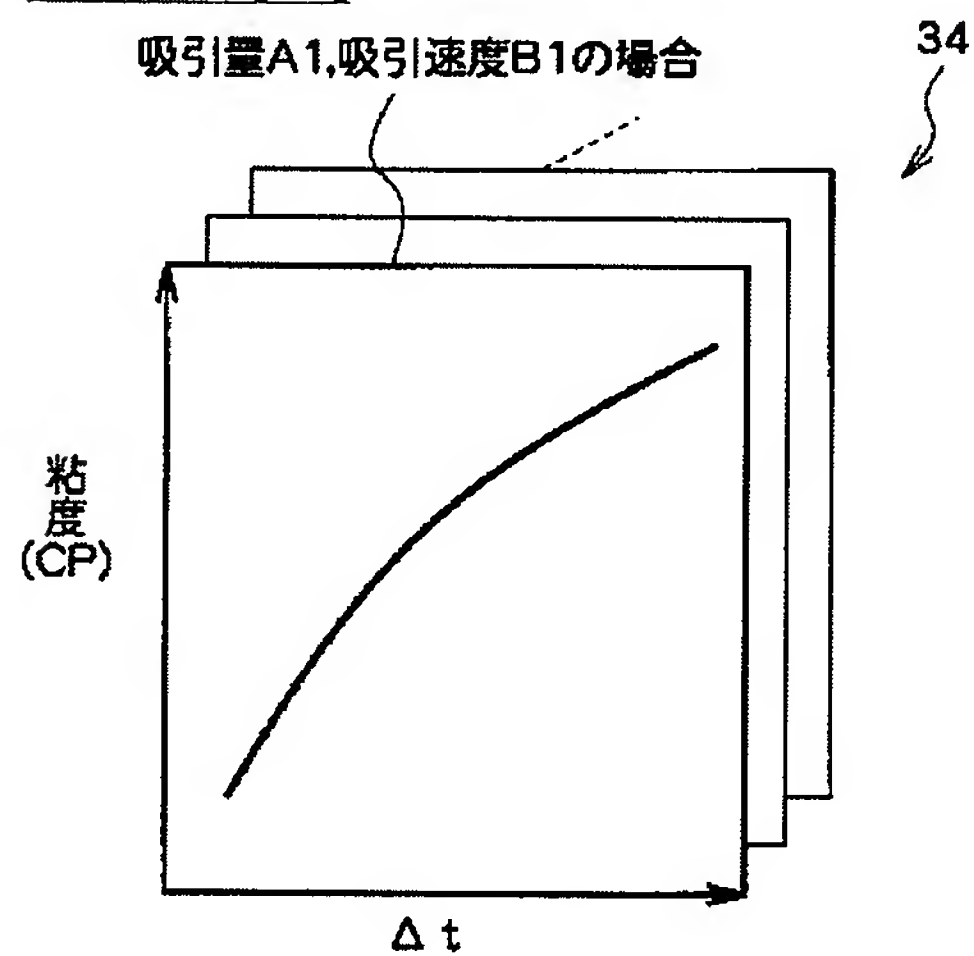
A : 吸引動作開始
 B : 吸引動作終了
 C : 復帰タイミング

[Drawing 3]



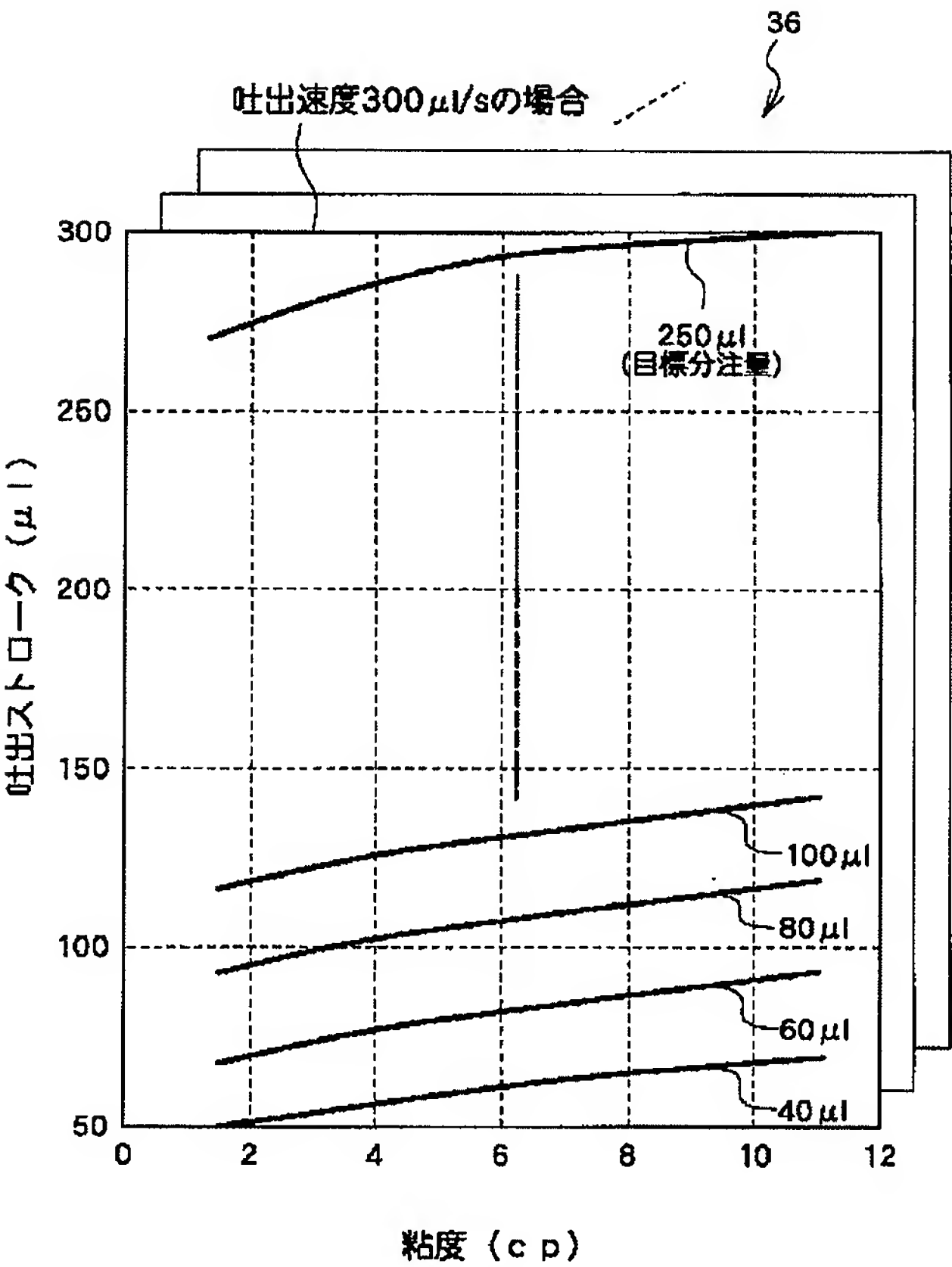
[Drawing 4]

吸引量A1,吸引速度B1の場合



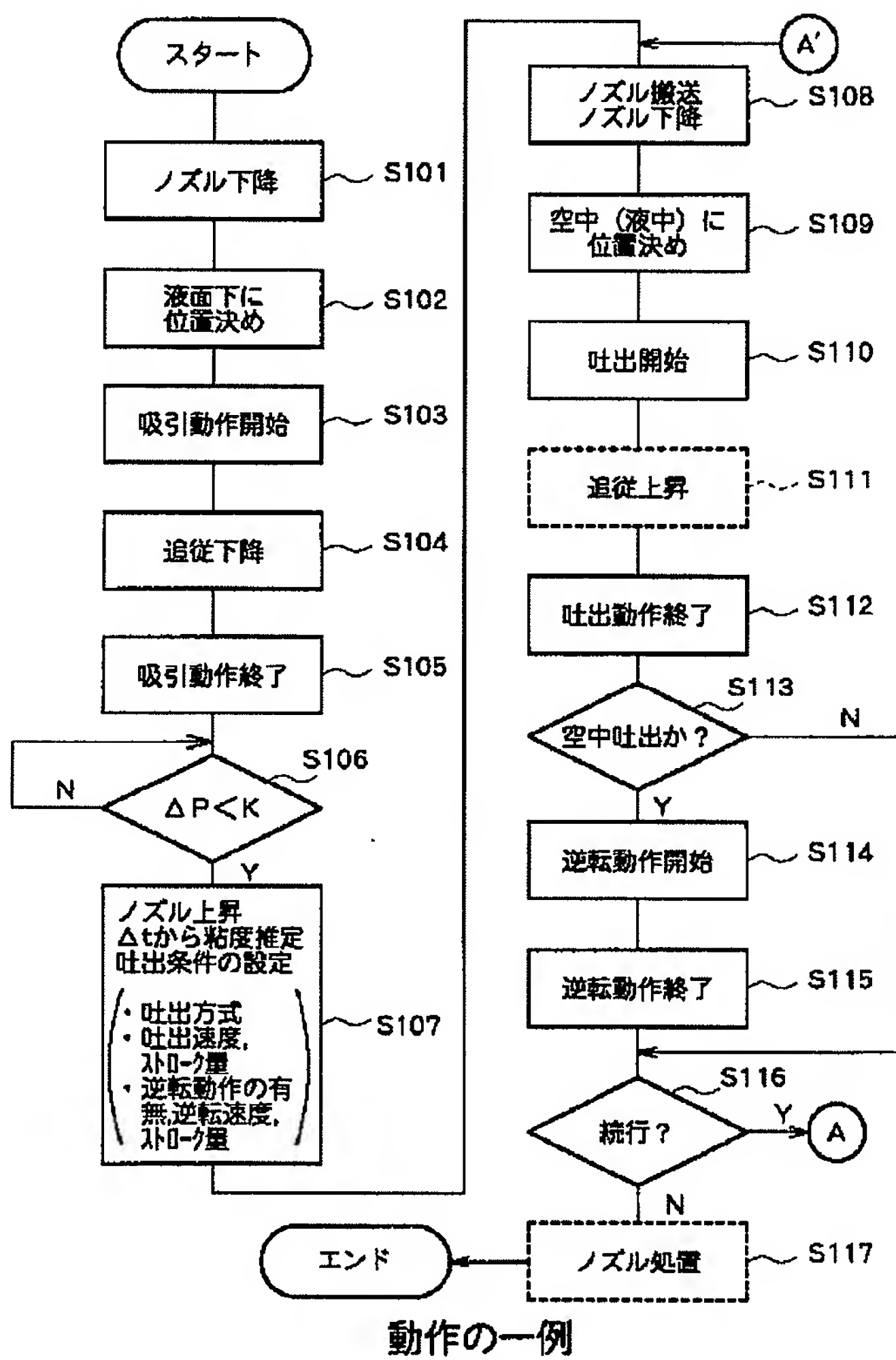
粘度テーブルの一例

[Drawing 5]



吐出条件テーブルの一例

[Drawing 6]



[Translation done.]

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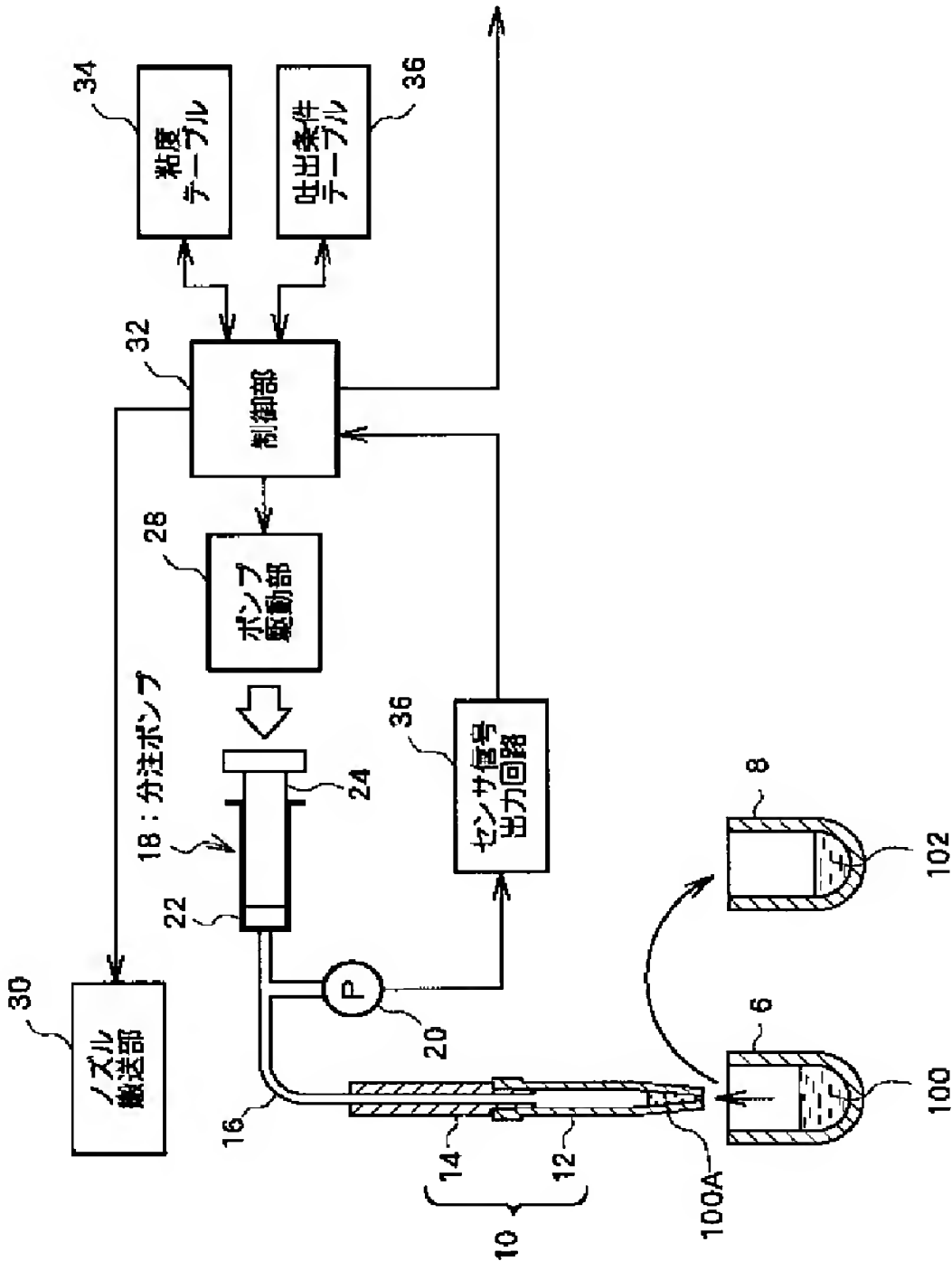
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		F ターム (参考)	2G058 EA01 EA14 EB01 ED15 ED21 ED31 GB10 GE03

(54) 【発明の名称】 分注装置

(57) 【要約】

【課題】 分注装置において、液体の粘度に応じて最適な動作条件を設定する。

【解決手段】 液体 1 0 0 の吸引時における圧力波形に基づいて、ノズル 1 0 を液体 1 0 0 の液面から離すタイミングが決定され、これと同時に、液体 1 0 0 の粘度が推定される。その推定された粘度に従って液体の吐出条件が決定される。その吐出条件には吐出方式、吐出速度や吐出ストローク量などの条件が含まれる。



【特許請求の範囲】

【請求項1】 ノズルと、
前記ノズルに対して配管を介して接続された分注ポンプと、
前記配管に接続された圧力検出器と、
前記ノズルを対象液体の液面内に進入させて対象液体の吸引を行う場合に、前記圧力検出器によって検出される圧力波形に基づいて、前記分注ポンプの吸引動作完了後における前記ノズルを上昇させる離液タイミングを判定する離液タイミング判定手段と、
を含み、
前記離液タイミングで前記対象液体から前記ノズルが引き上げられることを特徴とする分注装置。

【請求項2】 請求項1記載の装置において、
前記離液タイミング判定手段は、
前記分注ポンプの動作完了後における前記圧力波形の勾配を演算する手段と、
前記勾配が平坦化条件を満たす場合に前記離液タイミングを決定する手段と、
を含むことを特徴とする分注装置。

【請求項3】 ノズルと、
前記ノズルに対して配管を介して接続された分注ポンプと、
前記配管に接続された圧力検出器と、
前記ノズルによる対象液体の吸引時において、前記圧力検出器によって検出される圧力波形に基づいて、前記対象液体の物性を推定する物性推定手段と、
前記推定された物性に応じて前記ノズルによる対象液体の吐出時における吐出条件を設定する吐出条件設定部と、
を含み、
前記設定された吐出条件に従って前記対象液体が吐出されることを特徴とする分注装置。

【請求項4】 請求項3記載の装置において、
前記吐出条件設定部は、前記ノズルを液面から離して吐出を行う空中吐出方式、及び、前記ノズルを液面に接触させて吐出を行う液中吐出方式のいずれかの吐出方式を選択することを特徴とする分注装置。

【請求項5】 請求項4記載の装置において、
前記吐出条件設定部は、前記空中吐出方式の場合には分注ポンプの動作速度、分注ポンプの動作量、分注ポンプの逆転動作開始タイミング、及び、分注ポンプの逆転動作量の中の少なくとも1つを決定し、前記液中吐出方式の場合には分注ポンプの動作速度、及び、分注ポンプの動作後の離液までの待機時間の少なくとも1つを決定することを特徴とする分注装置。

【請求項6】 ノズルと、
前記ノズルに対して配管を介して接続された分注ポンプと、
前記配管に接続された圧力検出器と、

前記ノズルを対象液体の液面内に進入させて対象液体の吸引を行う場合に、前記圧力検出器によって検出される圧力波形に基づいて、前記分注ポンプの吸引動作完了後における圧力の平坦化時期を判定する平坦化時期判定手段と、
前記平坦化時期に従って前記ノズルの離液タイミングを判定する離液タイミング判定手段と、
前記吸引動作完了後から前記平坦化時期までの復帰期間に基づいて、前記対象液体の粘度を推定する粘度推定手段と、
前記推定された粘度に応じて前記対象液体の吐出条件を設定する吐出条件設定部と、
を含み、
前記対象液体に応じて前記離液タイミング及び前記吐出条件が適応的に設定されることを特徴とする分注装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は分注装置に関し、特に対象液体の物性に応じた吸引及び吐出の制御に関する。

【0002】

【従来の技術及びその課題】分注装置は、ノズルによって容器内の液体を吸引し、1又は複数の他の容器へ液体を吐出する装置である。具体的には、液体吸引時において、ノズルが液面内に挿入され、ノズルに接続された分注ポンプ（シリンジポンプ）を吸引動作させることにより、液体の吸引がなされる。ちなみに、通常、液体吸引に伴う液面下降に応じてノズル位置も追従して下降制御される。

【0003】分注ポンプの吸引動作完了直後において、ノズル内は依然として負圧（大気圧よりも低圧）となっており、よってノズル内の圧力が大気圧に近くなるまで、ノズル内に引き続いて液体が吸い込まれる。そして、圧力均衡が図られた時点で、ノズル内への液体の移動は停止し、吸引が完了する。この場合、分注ポンプの吸引動作完了時点から液体の吸引（移動）が実質的に完了するまでの期間（待機期間）は、それまでの吸引量及び吸引速度などに依存し、加えて、液体の物性（特に粘度）に依存する。従来装置においては、粘度が最も高い液体を想定し、そのような液体でも確実に吸引できる待機期間を前提とし、吸引後にノズルを上方へ引き上げる離液タイミングが一律に設定されていた。

【0004】一方、吐出時においては（特に後述する空中吐出方式の場合には）、分注ポンプの吐出速度かつ吐出動作量（空中吐出終期に液切れをよくするために実行される逆転動作量を含む）が同一であっても、液体の物性（特に粘度）の違いによって、実際の吐出量に違いが生じる場合も多い。また、粘度が低ければ、吐出速度を高めた方が分注処理時間を短縮できる。しかし、従来装置においては、粘度が最も高い液体を想定して吐出条件

を一律に設定していた。

【0005】また、吐出方式としては、空中吐出方式及び液中吐出方式が知られている。前記の空中吐出方式は、吐出先容器に既に他の液体が注入されている状態において、他の液体を吐出する場合に、当該容器内の液面よりも上方で吐出を行う方式である。この方式によれば、容器内の液体がノズルチップに付着することにより生じるコンタミネーションなどの問題を防止できる。分注する液体しかノズルチップに付着していないので、再度同一液体を分注するとき、ディスポーザブルノズルチップの場合はチップの再利用ができる。ノンディスポーザブルノズルチップの場合は、ノズルの洗浄工程を省略することができる。しかし、吐出する液体の粘度が極めて高いような場合には分注精度を確保するのが難しく、あるいは、吐出速度を一般に小さくする必要がある。一方、前記の液中吐出方式は、吐出先容器内に既に他の液体が注入されている状態において、他の液体を吐出する場合に、当該容器内の液面内にノズル（の先端）を進入させて、液体を吐出する方式である。吐出前にはノズル先端が液面に触れていなくても、吐出後の液面がノズル先端より高い位置になる場合も液中吐出方式に含まれる。この方式によれば、吐出する液体の粘度が高くても、比較的円滑に吐出を行うことができ、液切れもよいという利点がある。しかし、吐出先容器内に既に他の液体が入っている場合、容器内の他の液体がノズルチップに付着し、その結果、コンタミネーションなどの問題が生じ、あるいは、ノズル洗浄などの処理が不可欠となる。

【0006】このように、2つの吐出方式には一長一短があるが、従来装置においては、個々の装置ごとに、いずれかの方式のみが採用されている。なお、粘度測定機能をもった分注装置として、特開平5-107174号公報に記載された装置をあげることができる。但し、かかる装置は、測定された粘度に応じて動作条件の変更を行うようなものではない。

【0007】本発明は、上記従来の課題に鑑みなされたものであり、その目的は、分注対象となった液体の物性に応じて、分注処理効率を高められるようにすることにある。

【0008】本発明の他の目的は、分注対象となった液体の物性に応じて、その液体の吸引処理時間をできる限り削減できるようにすることにある。

【0009】本発明の他の目的は、分注対象となった液体の物性に応じて、最適な吐出時の動作条件を設定し、これにより分注精度を向上させ、また吐出処理時間を削減できるようにすることにある。

【0010】

【課題を解決するための手段】（1）上記目的を達成するために、本発明は、ノズルと、前記ノズルに対して配管を介して接続された分注ポンプと、前記配管に接続さ

れた圧力検出器と、前記ノズルを対象液体の液面内に進入させて対象液体の吸引を行う場合に、前記圧力検出器によって検出される圧力波形に基づいて、前記分注ポンプの吸引動作完了後における前記ノズルを上昇させる離液タイミングを判定する離液タイミング判定手段と、を含み、前記離液タイミングで前記対象液体から前記ノズルが引き上げられることを特徴とする。

【0011】上記構成によれば、対象液体をノズルによって吸引する場合に、分注ポンプの吸引動作完了後における圧力波形から、ノズルの離液タイミングが判定される。ここで、対象液体の物性に応じて、吸引動作完了後における圧力波形は異なり、その圧力波形に応じて離液タイミングを判定すれば、対象液体の粘度に応じて最小限の吸引時間を設定できる。

【0012】望ましくは、前記離液タイミング判定手段は、前記分注ポンプの動作完了後における前記圧力波形の勾配を演算する手段と、前記勾配が平坦化条件を満たす場合に前記離液タイミングを決定する手段と、を含む。

【0013】（2）また、上記目的を達成するために、本発明は、ノズルと、前記ノズルに対して配管を介して接続された分注ポンプと、前記配管に接続された圧力検出器と、前記ノズルによる対象液体の吸引時において前記圧力検出器によって検出される圧力波形に基づいて、前記対象液体の物性を推定する物性推定手段と、前記推定された物性に応じて前記ノズルによる対象液体の吐出時における吐出条件を設定する吐出条件設定部と、を含み、前記設定された吐出条件に従って前記対象液体が吐出される。

【0014】上記構成によれば、対象液体の物性が異なると、それらの吸引時における圧力波形が異なるため、その圧力波形に基づいて対象液体の物性が推定され、その物性に応じてふさわしい吐出条件が設定される。圧力波形から物性（特に粘度）を推定する場合、吸引初期の立ち下がり（圧力の急激な下降期間あるいはその急激な圧力低下幅）、吸引終期の立ち上がり（圧力の急激な上昇（復帰）期間）あるいはその急激な圧力上昇幅などの特徴量を用いるようにしてもよい。

【0015】望ましくは、前記吐出条件設定部は、前記ノズルを液面から離して吐出を行う空中吐出方式、及び、前記ノズルを液面に接触させて吐出を行う液中吐出方式のいずれかの吐出方式を選択する。望ましくは、前記吐出条件設定部は、前記空中吐出方式の場合には分注ポンプの動作速度、分注ポンプの動作量、分注ポンプの逆転動作開始タイミング、及び、分注ポンプの逆転動作量の中の少なくとも1つを決定し、前記液中吐出方式の場合には分注ポンプの動作速度、及び、分注ポンプの動作後の離液までの待機時間の少なくとも1つを決定する。

【0016】通常は空中吐出方式を選択し、特に粘度が

高いような場合に液中吐出を選択するようにしてもよい。この場合には、必要に応じて、ノズル（あるいはノズルチップ）の交換、ノズル洗浄などがなされる。一般に、粘度が低ければ吐出速度が大きくなり、粘度が高ければ吐出速度が小さくなる。これにより、分注処理速度が向上する。ここで、吐出条件には、更に空中吐出完了時点での逆転吸引動作の条件（逆転タイミング、逆転動作量など）も含まれる。

【0017】（3）また、上記目的を達成するために、本発明は、ノズルと、前記ノズルに対して配管を介して接続された分注ポンプと、前記配管に接続された圧力検出器と、前記ノズルを対象液体の液面内に進入させて対象液体の吸引を行う場合に、前記圧力検出器によって検出される圧力波形に基づいて、前記分注ポンプの吸引動作完了後における圧力の平坦化時期を判定する平坦化時期判定手段と、前記平坦化時期に従って前記ノズルの離液タイミングを判定する離液タイミング判定手段と、前記吸引動作完了後から前記平坦化時期までの期間に基づいて、前記対象液体の粘度を推定する粘度推定手段と、前記推定された粘度に応じて前記対象液体の吐出条件を設定する吐出条件設定部と、を含み、前記対象液体に応じて前記離液タイミング及び前記吐出条件が適応的に設定されることを特徴とする。

【0018】

【発明の実施の形態】以下、本発明の好適な実施形態を図面に基いて説明する。

【0019】図1には、本発明に係る分注装置の全体構成がブロック図として示されている。図1において、本実施形態においては、ノズル10がノズル基部14とノズルチップ12とで構成されている。ノズル基部14はパイプ状の金属などによって構成され、その下端側にはノズルチップ12の上端側が嵌合される。ノズルチップ12は樹脂などの透明部材によって構成され、上述のようにノズル基部14に対して着脱自在である。ノズルチップ12はいわゆるディスポーザブル型として使用される。

【0020】上記のように構成されるノズル10は配管16を介して分注ポンプ18に接続されている。配管16は例えばエアチューブなどによって構成され、分注ポンプ18はシリンジ22及びその内部において進退するピストン24によって構成される。シリンジ22に対してピストン24を前進させれば、ノズル10内の圧力が高まって液体の吐出が行われ、一方、シリンジ22に対してピストン24を後退させれば、ノズル10内の圧力が低くなってすなわち負圧となって液体の吸引が行われる。

【0021】本実施形態において、配管16には圧力センサ20が接続され、その圧力センサ20から出力された信号がセンサ信号出力回路26を介して後述する制御部32に出力されている。

【0022】分注ポンプ18はポンプ駆動部28によって駆動され、そのポンプ駆動部28は制御部32により制御されている。ノズル搬送部30はノズル10の三次元方向の搬送を行うものであり、このノズル搬送部30も制御部32によって制御されている。

【0023】本実施形態において、制御部32に接続された粘度テーブル34は、後述する期間 Δt に従って液体の粘度を決定（推定）するためのテーブルであり、その具体例については後に図4を用いて説明する。吐出条件テーブル36は、決定された液体の粘度に従って吐出条件を設定するためのテーブルであり、その具体例については後に図5を用いて説明する。

【0024】以上のように構成される分注装置において、ノズル10によって容器6内に収容されている液体（対象液体）100が吸引される。これが図1において符号100Aで示されている。吸引された液体100Aは他の容器8内に吐出される。この際、場合によっては、他の容器8内にはあらかじめ他の液体102が吐出されている。液体100Aの吐出方式としては、本実施形態において、上述した空中吐出方式あるいは液中吐出方式を選択することができる。

【0025】図2には、分注ポンプの動作と圧力波形とが対応づけて示されている。図2において（A）は図1に示した分注ポンプ18の動作を示しており、その図において波形が立ち上がった部分は分注ポンプ18が吸引動作を行っている期間を示している。また、（B）に示す圧力波形は、図1に示した圧力センサ20によって観測される吸引時の圧力変化を示すものである。ここにおいて、Aは分注ポンプ18の吸引動作開始のタイミングを示し、Bは分注ポンプ18の吸引動作の終了タイミングを示し、Cは圧力波形が平坦化した復帰タイミングを示している。

【0026】すなわち、図2（B）に示すように、ある粘度をもった液体を吸引する場合においては、その吸引動作開始の直後から圧力は急激に負圧方向に立ち下がり、その後一定の勾配をもって圧力が減少し、吸引動作終了とともに圧力が大気圧方向へ急激に上昇し、その後一定の負圧へなだらかに収束することになる。この場合において、 Δt は吸引動作終了後から圧力が平坦化して復帰するまでの復帰期間を示している。

【0027】本実施形態においては、例えば、上記の復帰期間 Δt が特定され、その復帰期間 Δt に基づいて吸引対象となった液体からノズルを引き上げるタイミング、すなわち離液タイミングが決定され、また、その復帰期間 Δt に基づいて吸引対象となった液体の物性、特に粘度が推定されている。そして、その粘度に応じて最適な当該液体の吐出条件が設定される。

【0028】すなわち、復帰期間 Δt は吸引対象となった液体の粘度に大きく依存し、粘度が高い場合には復帰期間 Δt が長くなり、粘度が低い場合には復帰期間 Δt

が短くなる。そこで、その復帰期間 Δt によって液体の粘度を推定するものである。もちろん、その復帰期間 Δt は吸引速度や吸引量などにも依存するため、それらの既知のパラメータを考慮した上で、 Δt の値を参照することにより、液体の粘度を精度良く推定することが可能である。

【0029】本実施形態においては、上記のように復帰期間 Δt を参照し、それをもって粘度の推定を行っているが、液体の物性を指標する他の特徴量としては、図2に示されるように、吸引初期時における立ち下がり時の圧力減少幅 b や吸引終了後における圧力の立ち上がり時点における圧力上昇幅 b' などを利用することもでき、それらも粘度の関数として利用可能である。更に、複数の特徴量を組み合わせてより精度良く粘度を推定するようにしてもよい。

【0030】上述した吸引量や吸引速度が既知であるのに対し、液体の粘度は未知であるが、従来においては想定される最も高い粘度を前提として離液タイミングなどを決定していたが、本実施形態によれば、未知の粘度を推定し、それによって最適な離液タイミングを決定できるという利点がある。また、後に詳述するように、推定された粘度に従って最適な吐出値の動作条件を設定することが可能である。

【0031】図3には、上記の復帰期間 Δt を決定するための手法の一例が示されている。図3においては吸引動作終了タイミングから復帰タイミングまでの圧力波形が部分的に示されている。この期間内においては、所定のサンプリング期間ごとに測定された圧力値の差分が演算され、その差分が所定の判定値 K よりも小さくなった時点をもって圧力が平坦化したものとして判定される。具体的には、あるタイミング T_i 及び T_{i+1} の2つの隣接するタイミングにおける2つの圧力 P_i 及び P_{i+1} の絶対値 ΔP が演算され、その ΔP が判定値 K よりも小さくなった時点をもって復帰タイミングが決定され、これと同時に復帰期間 Δt が決定される。もちろん、図3に示す手法は一例であって、これ以外にも他の手法を利用することもできる。いずれにしても、圧力波形の勾配を監視し、その勾配が平坦と見なされる条件を満たした場合に復帰タイミングを判定するのが望ましい。

【0032】図4には、図1に示した粘度テーブル34の具体例が示されている。この粘度テーブル34はある吸引量とある吸引速度の場合に、上記の復帰期間 Δt から粘度を決定するためのテーブルであり、吸引量、吸引速度、復帰期間 Δt の組み合わせに応じた粘度がテーブル化されたものである。もちろん、関数形式で粘度を求めるようにしてもよい。また、吸引量や吸引速度などが常に一定であるならば、復帰期間 Δt から粘度を一意に決定することもできる。

【0033】ちなみに、このようなテーブルはあらかじめ実験などによって決定しておくのが望ましい。

【0034】図5には、図1に示した吐出条件テーブル36の具体例が示されている。この吐出条件テーブルは上記の空中吐出に対応したものであり、吐出速度、粘度、目標分注量（吐出量）の組み合わせごとに吐出ストローク（吐出量）が対応付けられたテーブルである。このようなテーブルは、上記粘度テーブル34と同様にあらかじめ実験などによって作成しておくのが望ましい。ちなみに、吐出速度が一定であれば、それを前提として吐出条件テーブルを構成することもできるし、またテーブル構成によらずに吐出速度、粘度、目標分注量をパラメータとした関数形式によって吐出ストロークを決定するようにしてもよい。

【0035】ちなみに、本実施形態においては、制御部32が吐出条件を決定する場合において、粘度が所定値以上である場合には、液中吐出が選択され、それ以外の場合には空中吐出が選択されている。空中吐出が選択された場合には吐出条件テーブル36に従って吐出ストローク（及び吐出速度）が決定されている。液中吐出が選択された場合には、目標分注量に応じた吐出ストロークが一意に設定され、推定された粘度に応じて吐出速度、ポンプ動作終了からノズルチップの離液までの待機時間などの吐出条件が決定されている。また、本実施形態においては、空中吐出を行う場合に、吐出完了時に分注ポンプ18の逆転動作がなされており、これによって液切れがより良好となるように制御されている。この場合においても、その逆転動作開始のタイミングやその動作量などについて上記の推定された粘度に従って決定を行うようにするのが望ましい。

【0036】ちなみに、そのような逆転動作は微小ストロークだけ行われるものであるため、それについては粘度によらずに、固定条件としてもよい。

【0037】次に、図6を用いて図1に示した分注装置の動作例について図1を参照しながら説明する。

【0038】まず、S101では、吸引対象となった液体100を収容した容器6上にノズル10が位置決めされ、そのノズル10が下方に引き下ろされる。S102では、所定の液面検出を行って、液体100の液面下にノズル10の先端が例えば2mm程度進入した時点でノズル10の下降が停止される。

【0039】S103では、分注ポンプ18の吸引動作が開始される。これによって、ノズル10内に具体的にはノズルチップ12内にその先端開口を介して液体100が吸い込まれることになる。

【0040】この場合に、その吸い込みに伴って液面が下降するが、本実施形態においてはS104においてその液面の下降に伴うノズル10の位置の下降制御がなされる。

【0041】S105において、所定の吸引量だけ液体100の吸引が完了したと判断された場合、分注ポンプ18の吸引動作が終了する。

【0042】その後、S106では、図2(B)で示したように、吸引動作終了後の圧力波形の変動が監視され、圧力勾配が平坦化条件を満たすか否かが逐次的に判定される。具体的には、図3に示したように、一定期間ごとの圧力の差分値 ΔP が判定値Kと比較され、その差分値 ΔP が判定値Kよりも小さくなった時点で復帰タイミングと判定され、その復帰タイミングを離液タイミングとしてS107でノズル10が上方に引き上げられる。このように、圧力が所定値に復帰した時点をもって速やかにノズル10を引き上げることが可能であるので、液体の粘度に応じて最小限のノズル待機期間を設定することができ、吸引時間の削減を図ることが可能である。

【0043】上記S107では、ノズル上昇と共に復帰期間 ΔT から上述した粘度テーブル34を参照することによって液体の粘度が推定され、更にその推定された粘度に従って、吐出条件テーブル36などによって吐出条件が設定される。これは制御部32によって行われる。この場合において、吐出条件には、上述した空中吐出方式、液中吐出方式といった吐出方式の選択、空中吐出の場合は、吐出速度や吐出時のストローク量、逆転吸引動作条件など、液中吐出の場合は、吐出速度、ノズルチップ離液までの待機時間などといった諸々の条件が含まれる。

【0044】いずれにしても、液体の粘度が既知となるので、その粘度に従った最適な吐出条件が選択されることになる。

【0045】S108では、ノズル10が搬送され、吐出先の容器8上に位置決めされ、その後ノズル10が下方に引き下ろされる。S109では、S107で選択された吐出方式に従って、ノズル10が液面上にすなわち空中に位置決めされ、あるいはノズル10の先端が液中に位置決めされる。

【0046】S110では、分注ポンプ18の吐出動作が開始され、その後、S111では、必要に応じて液面上昇に伴ってノズル10が上方へ追従上昇される。もちろん、空中吐出を液面上昇分よりもさらに上方で行う場合においては、S111の工程は不要である。

【0047】S112では、目標分注量すなわち目標吐出量の液体が吐出されたと判断された時点をもって分注ポンプ18の吐出動作が終了される。

【0048】S113では、液中吐出か空中吐出かに応じて、逆転吸引動作を行わせるか否かが判断される。空中吐出の場合には、ノズルチップ先端の液切れのためにS114において分注ポンプ18の動作が吸引動作に転換され、その後、S115において当該逆転吸引動作が終了する。

【0049】S116では、ノズル10によって同一液体についての再吐出を行うか否かが判断され、そのような分注動作を続行する場合には、上記S108からの各工程が繰り返して実行され、その場合においても、S107で設定された吐出条件に従って吐出動作が行われる。

【0050】S117では、必要に応じてノズルチップ12の交換などの処理がなされ、その後、このルーチンが終了する。そして、必要に応じてまたS101からの各工程が繰り返して実行される。上記実施形態においては、ディスポーザブル型のノズルチップ12が利用されていたが、もちろんノンディスポーザブル型のノズルを利用する場合においても上記同様の手法を適用することができる。

【0051】

【発明の効果】以上説明したように、本発明によれば、分注対象となった液体の物性に依拠して分注処理効率を高めることが可能である。

【図面の簡単な説明】

【図1】 本発明に係る分注装置の好適な実施形態を示すブロック図である。

【図2】 分注ポンプの動作と圧力波形との関係を示す図である。

【図3】 圧力復帰タイミングの判定方法を示す説明図である。

【図4】 粘度テーブルの具体例を示す図である。

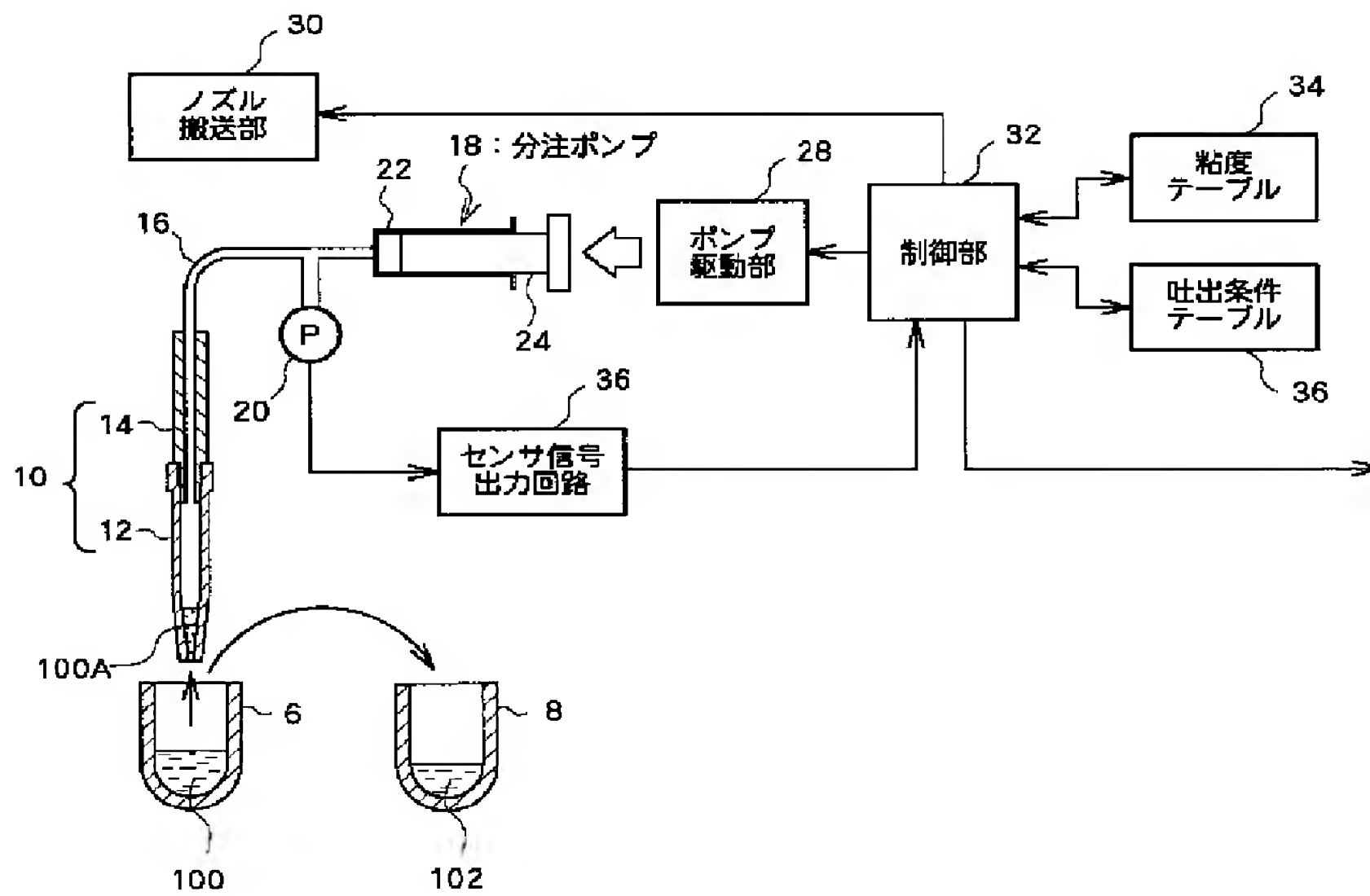
【図5】 吐出条件テーブルの具体例を説明するための図である。

【図6】 分注装置の動作例を示すフローチャートである。

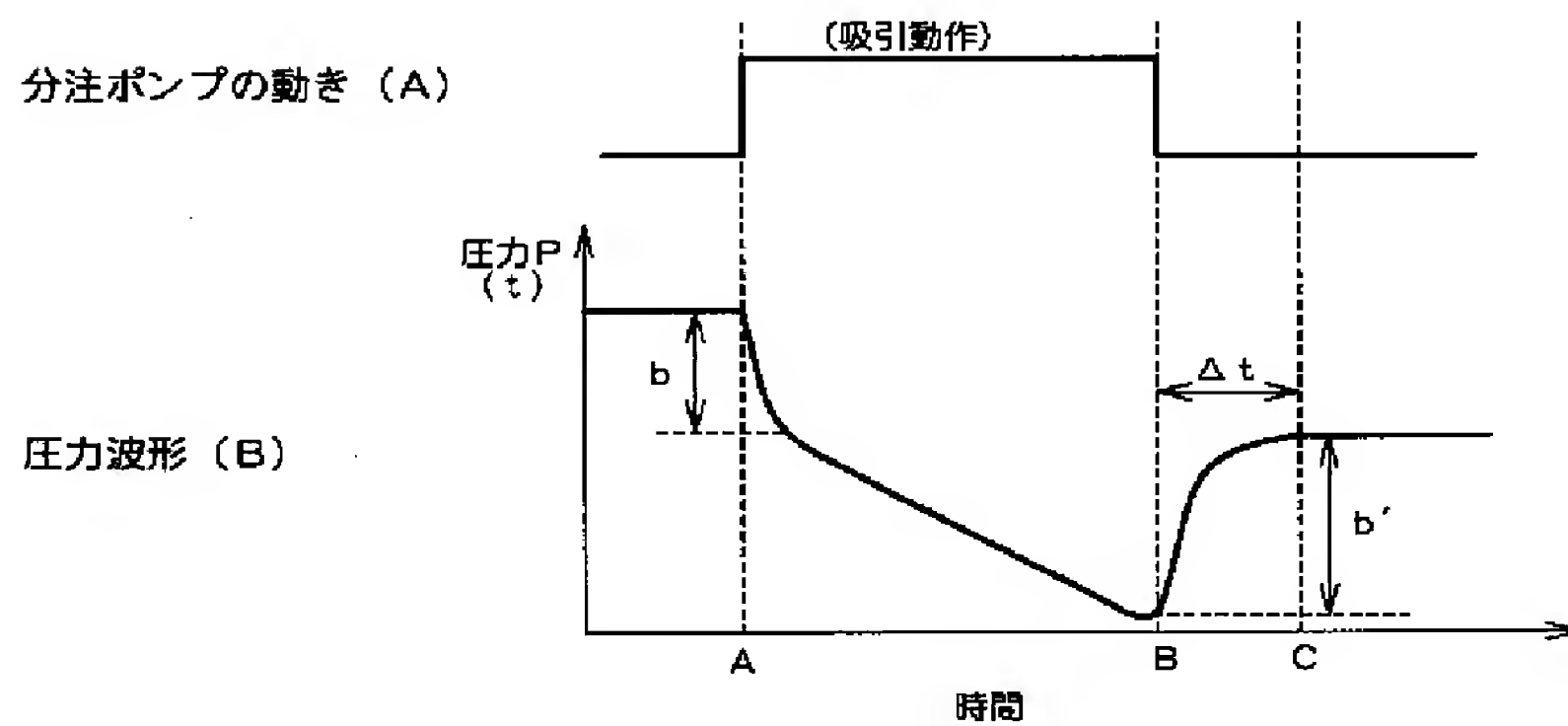
【符号の説明】

10 ノズル、12 ノズルチップ、16 配管、18 分注ポンプ、20 圧力センサ、22 シリンジ、24 ピストン、26 センサ信号出力回路、28 ポンプ駆動部、30 ノズル搬送部、32 制御部、34 粘度テーブル、36 吐出条件テーブル。

【図1】

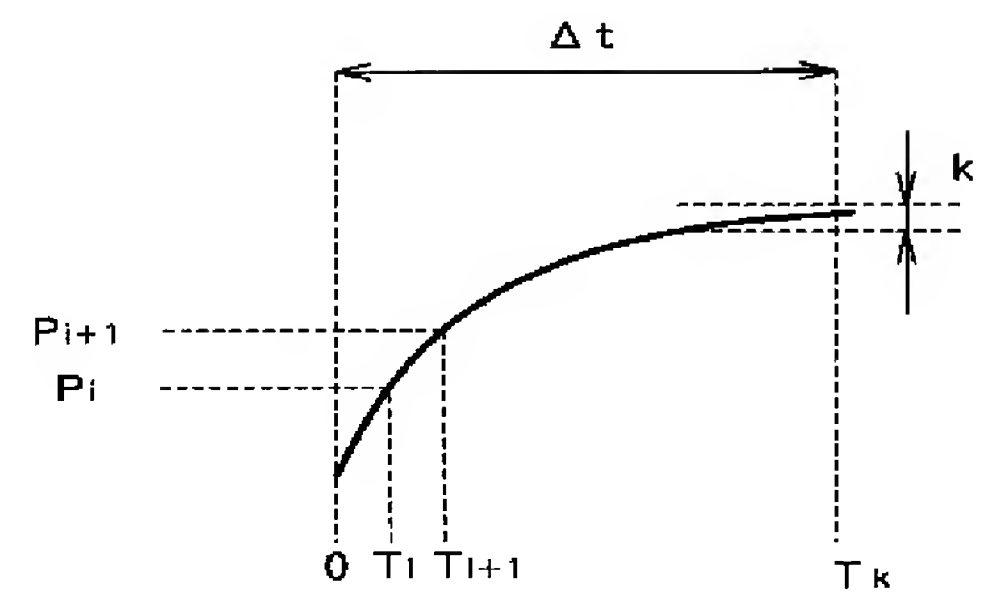


【図2】

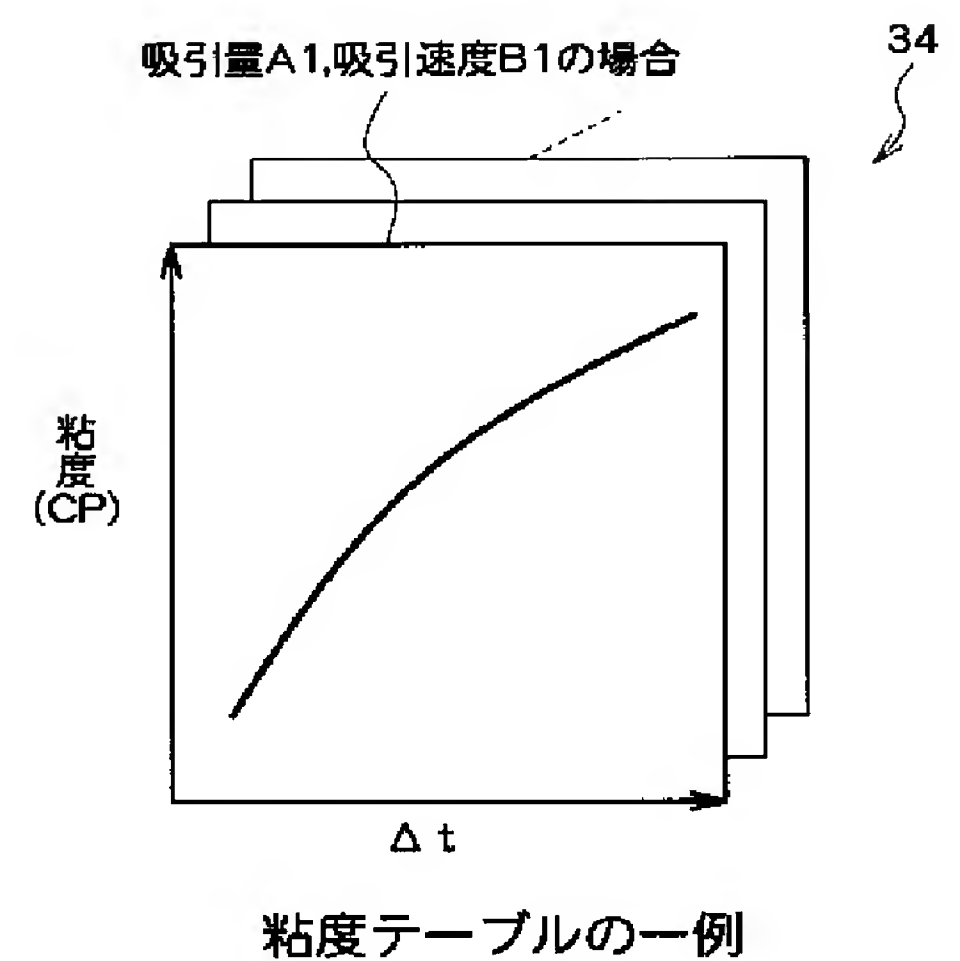


A: 吸引動作開始
B: 吸引動作終了
C: 復帰タイミング

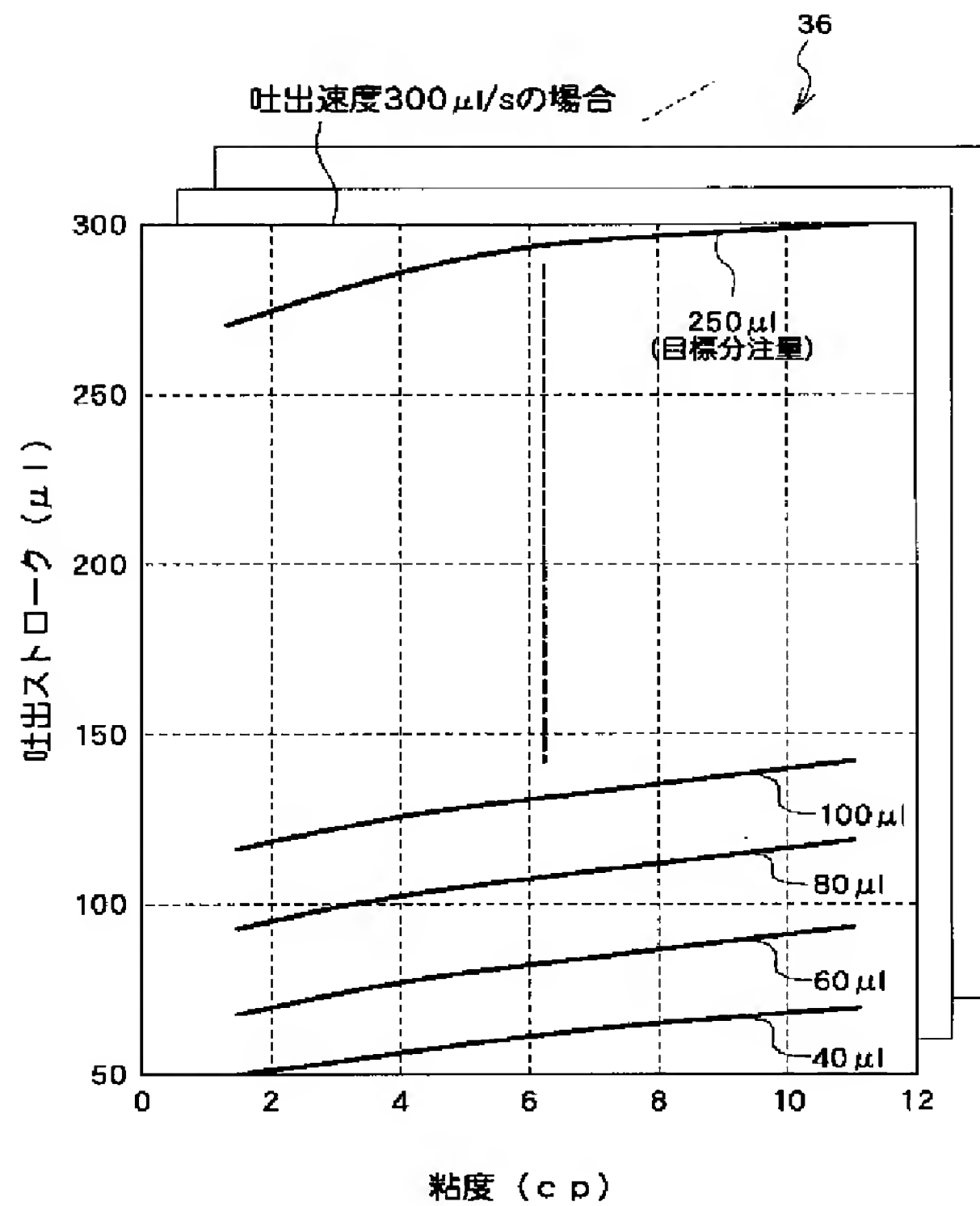
【図3】



【図4】



【図5】



【図6】

